EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN – AN IN VIVO STUDY

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In partial fulfillment of the requirements for the degree of

MASTER OF DENTAL SURGERY

(BRANCH – I)

(PROSTHODONTICS AND CROWN & BRIDGE)

2012 – 2015

CERTIFICATE

This is to certify that **Dr.T.MARIA SINGAM,** Post Graduate student (2012 - 2015) in the Department of Prosthodontics and Crown and Bridge, has done this dissertation titled **"EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN - AN IN VIVO STUDY"** under my direct guidance and supervision in partial fulfillment of the regulations laid down by **The Tamil Nadu Dr. M.G.R. Medical University, Guindy, Chennai – 32** for **M.D.S.** in **Prosthodontics and Crown & Bridge (Branch I)** Degree Examination.

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TRIPARTITE AGREEMENT

This agreement herein after the "Agreement" is entered into on this day, **December 23, 2014** between the **Tamil Nadu Government Dental College and Hospital** represented by its Principal having address at Tamil Nadu Government Dental College and Hospital, Chennai-3, (hereafter referred to as, 'the College')

And

Dr.A.MEENAKSHI,M.D.S., aged 48 years working as **professor** in the Department of Prosthodontics at the college, having residence address at No. 137, fifth street, secretariat colony, Kelleys,Chennai-10 (herein after referred to as the 'Principal Investigator')

And

Dr.T.MARIA SINGAM aged 32 years currently studying as Post Graduate student in the Department of Prosthodontics and Crown & Bridge, Tamil Nadu Government Dental College and Hospital, Chennai-3 (herein after referred to as the 'PG/Research student and Co-investigator').

Whereas the 'PG/Research student as part of his curriculum undertakes to research on the study titled **"EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN – AN IN VIVO STUDY"** for which purpose the Researcher and Principal investigator shall act as Principal investigator and the College shall provide the requisite infrastructure based on availability and also provide facility to the PG/Research student as to the extent possible as a Co-investigator.

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Witnesses

PG Student

1.

2.

DECLARATION

I, **Dr.T.MARIA SINGAM,** do hereby declare that the dissertation titled **"EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN – AN IN VIVO STUDY"** was done in the Department Of Prosthodontics, Tamil Nadu Government Dental College & Hospital, Chennai 600 003. I have utilized the facilities provided in the Government Dental College for the study in partial fulfilment of the requirements for the degree of **Master of Dental Surgery** in the speciality of **Prosthodontics and Crown & Bridge (Branch I)** during the course period **2012-2015** under the conceptualization and guidance of my dissertation guide, and professor **Dr.A.MEENAKSHI,M.D.S.,**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work and I firmly affirm that the right to preserve or publish this work rests solely with the prior permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

Signature of the PG student **Signature of the HOD**

Signature of the Head of the Institution

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ABSTRACT

Introduction: This study was performed to analyze methods to fabricate the restorations in harmony with both static and dynamic positions of mandible. This was attempted by using two different methods to incorporate functionally generated path by double casting technique and provisional restoration technique. By these methods the occlusal discrepancies encountered during fabrication of conventional restorations were eliminated.

Aim: Evaluation of occlusal discrepancy of cast metal fixed partial restoration by using three different fabrication techniques.

Keywords: Functionally generated path, Double casting, Provisional restoration, Pattern resin, Aluwax.

Materials and methods: The occlusal harmonies of the restorations fabricated by the three different methods were evaluated by T-scan using clusion and disclusion time. The readings were recorded and subjected to statistical analysis.

Results: The parameter of clusion time and disclusion time selected in the study has very little flexibilities, that is the time period between 0.1-0.3 secs was taken as the clusion time **in centric position** and the time period of less than 0.5 sec was set as the standard disclusion time **for eccentric positions**. It was found that the occlusal discrepancy was very minimal when the clusion and disclusion time was closer to these values.

Conclusion: Thus it was finally concluded that the restorations fabricated using functionally generated path technique by double casting method and provisional restoration method simulated the preexisting occlusion more closely and the difference between the two types of restorations were not significant. This proves that the functionally generated path technique is very useful for fabricating three unit fixed partial prostheses and can be used whenever the situations permit.

CONTENTS

LIST OF ABBREVIATIONS

Sl no.	ABBREVIATION	EXPANSION
1	FPD	Fixed partial denture
2	FGP	Functionally generated pathway
3	CR	Centric relation
4	MIP	Maximum intercuspal position
5	RL	Right lateral
6	LL	Left lateral
7	RS	Restorative side
9	NS	Normal side
10	P	Protrusion
11	PRE	Pre-existing
12	PRERS	Pre-existing restorative side
13	PRENS	Pre-existing normal side
14	PREP	Pre-existing protrusion
15	CT	Conventional technique

16	**CTRS**	Conventional technique restorative side
17	**CTNS**	Conventional technique normal side
18	**CTP**	Conventional technique protrusion
19	**DCT**	Double casting technique
20	**DCTRS**	Double casting technique restorative side
21	**DCTNS**	Double casting technique normal side
22	**DCTP**	Double casting technique protrusion
23	**FGPRS**	Functionally generated provisional restorative side
24	**FGPNS**	Functionally generated provisional normal side
25	**FGPP**	Functionally generated provisional protrusion

LIST OF PHOTOGRAPHS

S. No	PHOTOGRAPHS
1	Material and armamentarium used during diagnostic stage
2	Material and armamentarium used during diagnostic mounting and face bow transfer
3	Material and armamentarium used during tooth preparation, impression and temporization
4	Material and armamentarium used during die preparation, Wax and resin pattern fabrication and casting
5	Pre operative intra oral view - frontal
6	Pre operative intra oral view - occlusal
7	Diagnostic articulation
8	Occlusal view after tooth prepation
9	Placement of retraction cord
10	Final impression
11	Face bow transfer
12	Articulation done for fabrication of restoration
13	Die preparation and die spacer application

14	**Artificial tooth placed for fabrication of provisional restoration**
15	**Making putty index**
16,17	**Wax patterns before casting**
18,19	**Base crowns for FGP**
20,21,22	**Steps in fabrication of FGP by double casting**
23,24,25	**Fabrication of provisional restoration by FGP**
26,27,28	**Sprue placement**
29	**Cetrifugal casting machine used in the study**
30,31,32,33	**Restorations trial in the mouth**
34	**Sensor foil**
35	**T-Scan**
36	**Obtaining readings in T-Scan**

LIST OF FIGURES

LIST OF TABLES

LIST OF BARDIAGRAMS

INTRODUCTION

The best thing a man can achieve is to resemble nature because he cannot replace it. So it is necessary first to understand the natural stomatognathic system composed of teeth, muscles and TMJ. Nature has build the occlusal surfaces and incisal edges of the teeth to have certain curved pathways which balance and function harmoniously with the movements of the condyle in the glenoid fossa[1]. The human jaw with all its interferences and limitations makes the best articulator. Even the cusp, fossa or the inclination of the teeth is in harmony with this dictum of nature. So when we attempt to replace a single or many teeth especially in the form of a fixed partial denture, care is taken to replace these teeth closer to the position occupied by them naturally.

During chewing, as teeth are said to be extremely sensitive organs of the body any interferences in the restoration would be transmitted by proprioceptive mechanisms to the muscles thereby creating tension and compromising their function.

So this study to analyze methods to fabricate the restorations in harmony both during static and dynamic positions. This was attempted by using two different methods to incorporate functionally generated path by double casting technique[2] and provisional restoration technique[3,4,5]. By these methods the stumbling blocks encountered during fabrication of conventional restorations may be overcome. This makes the interdependent trio of occlusal harmony, muscular harmony and joint harmony to be successful.

An understanding of mandibular movements and use of fully adjustable articulator, simulating these movements is required, in order to achieve a harmonious occlusal scheme but the intricacies in the use of fully adjustable articulator make it not readily feasible for routine clinical practice.

This procedure sometimes becomes cumbersome and laborious in a routine clinical practice. So an alternative method to reproduce a most precise occlusion, which was developed way back in 1930's has become increasingly popular in the present days, is the FGP[2].

The original technique described by Meyer for obtaining the "functional occlusal path" for complete dentures[1] and fixed partial dentures[6] fabricated by a direct or indirect technique. Later the frontiers of this technique was expanded to be used in complete occlusal rehabilitation by Mann and Pankey.[7,8,9,10]. Recently FGP is becoming increasingly popular for the fabrication of implant retained FPD's[11].

This technique may be completed in two steps, either during the actual fabrication of restoration or as a three dimensional check bite technique to correct the completed restorations[12].

For overcoming some of these shortcomings of conventional casting technique, functionally generated path technique was implemented by two methods. First method is the double casting technique where the patient functional movements were recorded over the metal copings with retention beads attached to the occlusal surfaces. This technique of using pattern resin over the stable bases (metal copings) results in less dimensional inaccuracies during casting[2].

The second method of FGP is the castings made from autopolymerizing resin provisional restorations which was inserted and used by the patient for a period of two weeks[3]. Conventional methods of occlusal analysis like articulating paper[13], waxes[14,15], silicone impressions[16] and photo occlusions[17] do not satisfy the requirements of an ideal occlusal analyzer. Whenever articulating paper is used the depth of the colour mark, surface area, amount of force, timing of contact, sequence is not discernable[18,19]. Likewise waxes and

silicone pastes do not accurately reproduce the accurate occlusal contacts. However the reliability of these techniques is highly susceptible to inaccuracies due to the thickness, strength and elasticity of these materials in the oral environment[20]. The accuracy of these techniques is highly dependent on the clinician's discretion and it is not accurate[13,14,15]. Dental fraternity widely accepts articulating paper and shim stock as a standard for occlusal analysis. In 1987 the world health organization emphasized the importance of reliability in clinical measurement regarding oral health care.

An ideal occlusal indicator should exclude positional errors influenced by tooth displacement and extended mandibular movements[21]. Recently reports have come supporting the fact that T- Scan produces clinically better and reliable results when compared with conventional method of occlusal analysis. The digital occlusal analyzer system known as T-Scan was first introduced by the Chairman of Prosthodontics of Boston University, Professor William L. Maness in partnership with M.I.T.54[23]. Lorreta et al gave the confidence level of using T-Scan for craniomandibular practice.

The T-Scan System is a computerized device that consists of: 1) hand-held device with flat U-shaped pressure-measuring sensor, and 2) computer software. The latest type of this technology is marketed as the T-Scan III system, accompanied by a software version 8.0, Tekscan Inc. (South Boston, MA, USA). The pressure measuring sensor is a grid-based, Mylar-encased recording sensor (High-definition Generation IV sensor, Tekscan Inc. S. Boston, MA, USA).

The purpose of the present study is to compare the occlusal discrepancy of the castings made from a customized functionally generated provisional restoration technique and functionally generated path using a double casting technique with the conventional casting technique in fixed partial dentures.

AIM AND OBJECTIVES

AIM

Evaluation of occlusal discrepancy of cast metal fixed partial restoration by using three different fabrication techniques.

OBJECTIVES OF THE STUDY

1. To find out the occlusal discrepancy in fixed partial restorations fabricated using functionally generated double casting technique with the help of clusion and disclusion time.

2. To find out the occlusal discrepancy in fixed partial restorations fabricated using functionally generated provisional restoration technique with the help of clusion and disclusion time.

3. To find the occlusal discrepancy in fixed partial restorations fabricated using conventional technique with the help of clusion and disclusion time.

4. To find and compare the occlusal discrepancies of these restorations with the preexisting occlusion and also between the three restorations using clusion and disclusion time.

REVIEW OF LITERATURE

Meyer FS (1959)[1] Discussed the principles and procedures involved in the functional generated path technique for complete dentures. According to the author the two main hurdles in complete dentures are (1) absence of functional and balanced occlusion in centric relation as well as in all the excursions of the mandible. (2) Processing errors. The later can be minimized to a great extent, where as the former must be taken care of for fabricating a successful prosthesis.

The author discussed various most difficult and fundamental principles based on (1) functional occlusal path,

(2) centric occlusion,

(3) cusps and sulci analysis,

(4) development of cuspal paths and occlusal surfaces.

The author concluded that occlusal paths and cuspal paths generated in the mouth create records, which are in complete harmony with the condylar path and the neuromuscular system.

Meyer FS (1959)[6] Made a discussion on the use of the generated path technique in fixed partial denture fabrication. The author divided the procedure into various steps.

The basic steps include: abutment preparation, impression procedure, die and cast construction, mounting the casts and finishing fixed partial denture. The author came to a conclusion that if all procedures have been completed correctly, the finished fixed partial denture would fit the dies on the articulator with no tension or distortion. It will fit the patient's mouth in a similar manner, and correct occlusion and function are restored.

Mann AW, Pankey LD (1960)[7] The authors recommended the use of P-M instrument for restoring lower posterior teeth. The authors listed the purposes of the P-M instrument as follows; a) To evaluate the entire oral rehabilitation before a single tooth preparation is made. b) To decide the occlusal plane on the lower cast. c) To study and plan the preparations of lower and upper teeth. d) To orient the relationship of both the arches in centric position at the same time providing maximum esthetics and conservation of tooth structure. e) The guide's planes are to be prepared and buccal contours are to be waxed on the teeth of the mounted study casts, exactly as they will be in the finished restorations. f) To establish and carve the occlusal plane and curvature in the wax patterns and g) To check the finished restorations.

The authors concluded that the reconstruction of the maxillary posterior teeth and cuspids should be accomplished after permanently arranging the lower posteriors. The maxillary incisors may be built either before or after these procedures are completed.

Zimmermann EM (1966)[24] In this article made a review of the principles of the functionally generated path technique. The author pointed out certain hazards and suggested modifications of the functionally generated path technique. The author described the functionally generated path record as a "three dimensional static expression of dynamic tooth movement''

According to the author, when the functionally generated path procedures have been

1) The opposing anterior teeth will contact in both centric and eccentric positions.

2) The posterior centric holding studs will clearly show through and be flush with the functional wax.

3) The functional wax will be smoothly carved or shaped by the action of the stylus over lower buccal cusps.

Edalat MP, Khadjavi K (1973)[5] Described a simple, accurate and time saving technique for the fabrication of a fixed partial denture in which both a chew in technique and a one piece casting were assimilated.

The authors suggested the use of acrylic crowns as a base to carry the FGP recording material, to eliminate any dimensional changes occurring due to soldering and double casting.

Azarmehr P, Azarmehr HY, Javdan B (1974)[32] Described a technique to fabricate functional occlusion for porcelain fused to gold restoration using the Meyer's chew–in technique. The authors used metal copings as a foundation to develop the occlusal form in blue inlay wax. The occlusal morphology was developed initially in the articulator and later improved in the patient's mouth. A negative key was fabricated in stone against which the porcelain occlusal surfaces could be fired.

The authors came to a conclusion that this technique allows the dentists to incorporate the functional occlusion in porcelain fused to Gold restorations without the use of any complicated instruments.

Kafandaris NM (1981)[3] The purpose of this article was to describe a technique which is more simplified Since the functionally generated path technique is best for restoration of the maxillary posterior teeth, a fixed partial denture with porcelain occlusal surfaces was described as a modification of Meyer's technique. The FGP was generated in soft registration wax (Tacky-wax) using the FPD frame work as the foundation and with adequate occlusal clearance. The functionally generated path was used to develop a functional core, which was utilized for constructing the interim restorations in acrylic resin. The interim restoration was inserted in the patient's mouth for 2-3 weeks to wear off any possible interference. A new functional core was now developed against which the ceramometal restorations could be fabricated.

Melvin A.Engelman, Curtis L.Engelman, (1983)[4] Conducted a study where it is said that FGP harmoniously reproduces the occlusal surfaces with minimal chair side adjustments and avoids the need for counter models and adjustable articulators for construction of inlays, crowns and short span fixed partial dentures. Here a simple technique is implemented making the use of FGP tray, FGP fast set stone and FGP wax to establish the occlusal surfaces of the restorations.

Michele Cacciali, Massimo Fuzzi, Alessandro Treccani, P.L.Negri, (1984)[30] accordingly to this study, FGP facilitates the registration of kinematic relation of different occlusal positions only when the anterior guidance is coincident with the present occlusal situation in the absence of interferences. In this procedure, tacky wax is opted for as it has sufficient working time and reproduction of the functional pathways is better in comparison with other materials. Simple articulators like twin stage occluder, verticulator and Denar's correlator are preferable in this technique for having a good control of centric occlusion.

Lacy AM, Fukui H, Jendresen MD (1983)[44] Conducted a study to investigate the effects of (1) Mixing rate (2) ring liner position and (3) storage conditions on the setting expansion of the gypsum-bonded and phosphate bonded investment molds and then subsequently correlate the casting size with measured expansion data. Results revealed the fact that the position and extent of ring liners, rates of mixing, and conditions of storage may be even more important in determining ultimate casting size than the classically accepted factors such as liquid/power ratios or number of ring liners. In conditions where the molds were to be stored over night, dimensional changes were minimal when they were kept in 100% relative humid atmosphere, particularly if CaSO4.2H2O containing gypsum bonded investments were used.

Balshi TJ (1986)[36] Proposed a method to resolve the esthetic complications that occur with osseointegration using a double casting technique. The author states that this technique maintains the esthetic integrity of the facial surfaces of the prosthetic teeth and easy access for future maintenance.

William L.Maness, Micbael Benjamin (1987)[23] According to them, T-Scan is a computerised device used to diagnostically quantify occlusal contacts in three new ways: balance plot, time display and comparison screen. It provides the dentist with greater ability to visualise, diagnose and treat complex occlusal problems. The display compares the occlusal contact patterns prior to and after treatment and assessing the similarity and reproducibility of closure patterns and at the same time recording it.

Eeckman J, De Boever JA (1988)[31] In their study investigated the accuracy of three different types of waxes used for functional interocclusal registrations under conditions comparable to the clinical situation. The authors used three waxes specifically recommended for functionally generated path (FGP): Ash bite registration wax, Tacky Synthetic Wax and HifiJelenko functional bite material. The authors finally came to a conclusion that, complete reproducibility of centric and eccentric contact areas could not be found in all these situations. They further emphasized the need for a plastic material, which could sustain the mouth temperature and register the static centric and eccentric registrations more reliably.

Dawson PE (1989)[12] Described the functionally generated path for recording of precise border pathways. The pre-requisites for the use of this technique were described and the steps for bilateral recording of the functionally generated path for both the maxillary and mandibular teeth were described in detail. Use of FGP for quadrant dentistry, for a single tooth and for cross bite was described. The author also illustrated the various difficulties encountered during the FGP procedure and methods to overcome those difficulties.

M.Reza Moini, Peter A. Neff (1991)[20] According to him T-scan is an accurate device as it reproduces actual occlusal contacts, timing and force of each contact and records these datas for research and analytical purposes.

It overcomes the shortcomings of conventional methods like effect of saliva, inability to store the data , non standardisation in thickness, strength, marking substance etc., in this study T-scan reproduces the same contacts recorded by the silk ribbon in 100% of the trials**.**

Hansen CA, Clear K, Wright P (1994)[33] Described a procedure to reproduce the occlusal morphology of complete denture and removable partial denture teeth or those of an implant supported prosthesis in gold.

The authors used resin teeth in the prostheses after reducing the occlusal surfaces by approximately 1.5 mm. A wide strip of Almore bite registration wax was utilized to create occlusal morphologies in the patient's mouth. The authors suggested this technique as a simple and accurate method, which could be used for routine dental practice.

Kerstein (1994)[47] In his study found that combined right and left disclusion time were comparatively greater in cases of MPDS, Open occlusion, Orthodontic treatment. Pre-treatment disclusion time analysis aids the clinician to find out whether the elevated levels of contractile muscle activity in masseter and temporalis muscles was created by the existing occlusal scheme.

Anusavice KJ (1996) [40] Described the various types of inlay waxes, their composition and the desirable properties. The author also discussed the various stresses developed in the waxes during handling leading to their distortion and their manipulation of inlay wax was described in detail.

Hammad IA, Nourallah H (1996)[25] Described a procedure to enable the clinician to record occlusal and border anatomy at the correct vertical dimension. The authors suggested the use of a Vaccu-Press machine to make a plastic coping of a clear acetate sheet, which was 1.5 to 2 mm short of the margins. Duralay acrylic resin was used to contour the axial portion of the pattern keeping it 1 mm short of the margin, and the occlusal surfaces were made out of contact with the opposing cast or the opposing teeth in the mouth. Functional wax was used to create a functionally generated path in this technique. The authors concluded that this technique was a simple and accurate method to develop a functional occlusion.

A.Garcia Cartagena, O. Gonzalez Sequeros (1997)[52] Made a study to analyse the occlusal contact registration with the T-Scan using two methods like time and force analysis modes. It is found that the number of contacts differ both between patients and between four mandibular positions like maximum inter cuspation, edge to edge protrusion , right and left laterality. Time mode registers most contacts, force records least variability, but in either case dispersion of data is small and finally T- scan is found to be reliable.

V.C Garrido Garcia, A. Garcia Cartagena,O. Gonzalez Sequeros (1997)[51] Made a study to evaluate the occlusal contacts in maximum intercuspation using T-Scan. The variation within subjects is very less when compared to between subjects and this is used as a new identification method like that of genetic markers, sweep microscopy. It is identified based on the number and distribution of contacts, even with the data as little as seven teeth.

Schillngburg HT, Hobo S, Whitsett LD, Jacobi R (1997)[41] The authors suggest that there are certain pre-requisites for the use of this technique in the restoration of a single tooth. They are as follows; 1) presence of an optimal occlusion; (2) Correct anterior guidance along with absence of posterior interferences when the restoration is made; (3) There should not be any missing or broken down opposing teeth; (4) Badly rotated, carious or poorly restored teeth in

the opposing arch will not be able to provide the occlusal pathways needed for shaping of the occlusal surfaces.

By using tacky wax functional tracing was made immediately following occlusal reduction and the obtained functionally generated path was used to develop the functional core, which was mounted onto the twin stage occluder. The occlusal morphology was first developed against the anatomic cast and later verified against the functional core obtained . The authors concluded that the FGP technique is a simple procedure and produce excellent results.

Minagi S, Tanaka T, Sato T, Matusuaga T (1998)[2] Presented an innovative technique for fabrication of fixed prosthesis that requires precise occlusion. Their investigation revealed experimental data supporting the fact that the double casting technique was a viable approach in accurately reproducing a difficult occlusal topography for a cast restoration.

A master abutment was made of silver gold palladium alloy with a 4-mm height and 6° of taper. 2 wax patterns were fabricated on the master abutment, one for the conventional casting and the other for the double casting technique. The latter had an occlusal clearance on to which retentive beads were attached. The wax patterns were cast, using Ag-Au-Pd alloy and the castings of the base crown were fitted to the master abutment.

Autocuring resin was added to the occlusal surfaces of the base crown (made for double casting technique) to create the experimental occlusal surfaces. After analyzing the results, the following conclusions were drawn;

1. The clinical error for a double casting method was significantly to a lesser degree than the conventional casting method.

2. The double casting method was found to be more reliable than the conventional casting method because of the minimal errors observed with this method.

Karne M, Patyk A, Kobes LWR (1998) [42] The purpose of this study was to determine the surface structure of 16 residue-free burning resins and to know which resins could replace the waxes used in the double casting technique.

The authors came to a conclusion that the surface structure of the residue free resins (Palvit G, Pattern Resin, Visio Form, Novolen Hostalen, Lupolen) were within an acceptable range for the dental casting technique. An increased application of these residue free resins in dental casting technique is therefore being recommended. These resins could not only complement waxes or wax / resin compositions, but could even, replace them.

Curtis SR (1999)[26] The author made a review and emphasized the drawbacks of using the previous techniques and use of a soft functional wax for functionally generated path for fabrication of ceramometal restorations. The prosthesis was casted and later prepared for porcelain addition. A full contour wax-up was made with inlay wax and patient was instructed to perform the various mandibular excursions. A stone index /matrix of the occlusal path obtained in wax and porcelain was veneered on to the framework using the stone matrix to guide its placement.

The author concluded that the advantages of this technique, over the conventional method are that; 1) A functional path tray is not required, 2) Inlay wax which is harder and more resistant to distortion is utilised, 3) Laboratory procedures are made simple with the help of the stone matrix.

Davies SJ, Gray RMJ, Smith PW (2001)[34] Developed guidelines for a good occlusal practice using the confirmative approach. Among the guidelines they enumerated a thorough examination of the patient's teeth, periodontium, articulation of teeth and recording of occlusion before treatment was suggested. They devised an occlusal sketching method on acetone sheet which was two-dimensional and found to be user friendly way to record the

patient's occlusion. The authors stated that the confirmative approach is the safest way of ensuring harmless post restoration occlusion and that finally the post treatment occlusion should be a product of examination, design, execution and checking (EDEC).

The authors recommended various other techniques for occlusal analysis, which included the photographic method and three-dimensional bite registration methods.

Rosenstiel SF, Land MF, Fujimoto J. (2001)[43] These authors described the various procedures involved in the tissue management and impression making for fixed partial dentures. The authors also discussed many factors regarding the fabrication and material science of wax patterns.

In-Sung Yeo and Jae-HoYang (2001)[29] Made a study where it is found that incorporation of group function occlusion in fabrication of fixed partial dentures is not easy when compared to mutually protected occlusion as it is difficult to achieve it by gnathologic instruments. Functionally generated path concept solves this problem easily where occlusal restoration of the prosthesis is customised to the patient's own occlusal patterns.

R. W. Wassell G. St. George R. P. Ingledew and J. G. Steele (2002)[39] Made a review on provisional restorations based on functions, materials and techniques. Their functions are comfort, positional stability, function, gingival health and contour esthetics, diagnosis etc., the materials may preformed crowns, self or light cure resin and cast metal. They may be fabricated by direct technique or indirect technique. Problems may arise due to insufficient bulk of material, marginal discrepancies, multiple crowns and premature decementation. An initial diagnostic wax up is mandatory for construction laboratory formed provisionals.

Hajime Shirai, Jun-ichiSejima, Yuka Mantani, (2002)[38] Conducted a study were patients with highly keen oral sensory complaints are restored with fixed partial dentures using double casting method. It not only provides functionally generated occlusal path but also precise outline form adapting to the surrounding soft tissues. The advantages are, it avoids the technical errors in casting, error in the distortion of opposing cast, occlusal registration, mounting and errors caused by proximal contact with adjacent tooth as the fitting is checked prior to molding of occlusal surfaces.

Sutton AJ, Sheets DW Jr, Ford DE (2003)[11] This article described a functionally generated path technique to obtain optimal articulation between an implant-retained fixed partial denture and the patient's natural dentition. Single tooth provisional crown copings were attached to the implant replicas and pattern resin was placed all around the copings. The pattern resin copings were lubricated, and a functional impression wax was added onto the occlusal surface of the recording table and the functionally generated occlusal path was generated by guiding the patient to perform the MIP and eccentric movements. A dental stone core was poured into the wax recordings obtained, which was subsequently used for fabrication of final restorations.

Luk HWK, PowEHN, McMillan AS, Hui CF (2004)[37] Presented a simple, two stage casting technique that avoids common problems like shrinkage associated with the casting of large superstructures. This new method permitted the fabrication of a passive fitting implant framework by 2 castings, completely encasing the first casting with the second. The first casting was used as a rigid base to allow precise fit of the framework. It reduced the volume of the second casting and hence limited any untoward effects such as distortion. The second casting that completely encased the first solved the problems of potential weak joint strength in the casting or soldering technique.

Peter S. (2004)[45] Discussed the epidemiology, etiology and prevention of dental caries. The author evaluated the caries susceptibility of individual teeth. According to those epidemiological surveys the upper and lower first molars are 95% susceptible to caries, hence the most common missing teeth in the whole dentition.

Kerstein, John Radke (2006)[48] Clinical observations of 62 patient's precision measurements obtained with the simultaneous recording of excursive function and muscle activity levels demonstrated that reduction in prolonged disclusion time from an average of 1.4 seconds per excursion to less than 0.41 seconds per excursion, created a therapeutic effect. Within one month time following treatment, increases in the treated subject's maximal clenching capacity in the masseter and temporalis muscles were noted. This treatment effect appears to be the result of decreased ischemia in these same muscles resulted from decreased compression time of the posterior teeth into their periodontal ligament fibers during excursive function. This increase in maximal clenching capacity provides additional evidence supporting the previously described explanations for the reported MPDS symptom reductions resulting from disclusion time reduction therapy.

Jorge A. Learreta, Jorge Beas, Andrea E. Bono, Andreas Durst (2007)[55] The purpose of this study is to determine the electromyographic response of masseter, temporalis , digastric and trapezius group of muscles when 0.4mm premature contacts were placed in different teeth and monitored by T-scan. The interferences compromise the neurological reflex to induce muscle activity disorders by reducing the activity of these muscles due to the interferences. But the trapezius muscles increases its activity. The reduced activity of the muscles alters the painful proprioception and prevents maximal contraction. So both EMG and T-scan are important for assessing the occlusion precisely.

Pokorny PH, Wiens JP, Litvak H. (2008)[28] Gnathological concepts offer a systematic methodology for prosthodontic treatment in the presence of a disorganized or dysfunctional occlusion requiring fixed prosthodontics. Gnathology will be judged as a significant stimulus to relate the physiology of occlusion to biomedical concepts in complex restorative treatment. The lack of an evidence-based model does not diminish the goal of precision and excellence in the clinical management of fixed prosthodontics. Ultimately, the clinician must evaluate and assimilate the available literature and research evidence along with individual clinical experiences and accepted parameters of care. Occlusal factors have different effects in different individuals. So the guideline is developed based on consensus, clinical research outcome studies.

E Prashanti, Suresh Sajjan, Jagan Mohan Reddy (2009)[35] Accordingly, double casting technique is basically an error compensation step as it eliminates the inherent dimensional errors of indirect method. The possible errors are only related to investing, casting and polishing procedures and it avoids the tedious job of metal trimming where the occlusal morphology may be lost in an attempt to correct the interferences. Thus the occlusal morphology becomes closer to normal anatomy of teeth definitely leading to improved patient satisfaction and confidence.

Bernd Koos, Arnim Godt, Christine Schille, GernotGoz (2010)[49] Made a study to evaluate the precision of instrumentation based method of analysing occlusion and its resulting distribution of forces in the dental arch. It was found that level of accuracy with T-Scan is acceptable and changing of foil or repeated measuring had no influence on results. However a combination of methods is preferred as the pressure sensitive foils do not make the markings intra orally.

The T-scan systems measures the distribution of forces per tooth, both the halves of jaw and the center of force each time, thus the premature contacts and interferences in dynamic occlusion are identified easily.

R. B. Helms, T. R. Katona & G. J. Eckert (2011)[57] The aim of the study is to find out whether the products like Accu film I&II, articulating silk (thick and thin), T-scan alter the occlusion during the detection of occlusal contacts. It is found that the flexibility of the testing device influences the measured load and thin, plastically deformable detection products are preferred because the stiffer products create a negative neuromuscular response. The effects of these products are multifactorial like mechanical properties, thickness and surface friction. So more research is needed to overcome the disadvantages and help in the better performance**.**

Sarah Qadeer, Robert Kerstein, Ryan Jin Yung Kim, Jung-Bo Huh, Sang-Wan Shin (2012)[18] Made a study to determine the relationship between the size of the articulating paper marks and the percentage of force applied to the same tooth. There was a low positive correlation of 38.3% even with the largest paper mark. It is evident that tooth morphology is the important factor deciding the actual paper mark surface area. Sometimes a large mark can have a low force and a large mark can have a higher force associated with it. So this is not an accurate indicator and employment of non subjective quantifying occlusal indicator becomes essential.

Aneta Wieczorek, Jolanta Loster, and Bartlomiej W. Loster (2012)[56] The study aims to investigate whether symmetry of EMG activity in asymptomatic young adults relates to the symmetry of occlusal contacts. The two systems combined make in possible to record simultaneously the force, timing and balance of craniofacial muscles and occlusion. The study reveals that most subjects had a right side temporalis anterior muscle dominance. The right

handed tendency of anterior temporalis muscle may be corrected by left handed asymmetry of the masticatory muscles. To conclude the symmetry of EMG activity in asymtomatic young adults has no correlation with symmetry of occlusal contacts.

Nicholas B. DuVall & Paul M. Rogers (2013)[27] Conducted a study where FGP technique was used in the fabrication of mandibular posterior restorations in a patient with Bilateral Group Function Occlusion in order to eliminate the interferences. Here a stone crib is used to capture FGP recording at the same time indexing it to the contralateral and ipsilateral mandibular dentition. This procedure provides stability to the stone core and reduces the error during mounting.

Satheesh B. Haralur (2013)[46] This study that the functional dynamic occlusal contacts were evaluated by conventional method and T Scan analysis for subjects with TMD and normal joints. Within the limitations of the study, it can be concluded that the balancing side interferences and centric slide was more than 2 mm found to have a strong association with TMD. The study indicates that the susceptibility to temporomandibular disorders were more prevalent in group function occlusal scheme. The T scan III results concluded that both occlusion time and disclusion time in the patients with TMD disorders were significantly extended than the normal subjects.

Mario Jorge da Silva Martinsa, Francisco Jose Caramelob, Julio Andre Ramalho da Fonsecaa, Pedro Miguel Gomes Nicolaua (2014)[58] Conducted a study to find out the sensibility and reliability of T-scan III HD system for intra oral use by comparing it with similar heterogenic anatomic circumstances. It is said that any time occlusal data recorded, those closures are taken as a conditioning period to adapt to the individuals tooth morphology,

assess the patient's occlusal strength and acclimatize the patient to intercuspate well for future recordings.

So the gold standard for diagnosing occlusal interferences and prematurities involves a combination of patient self report opinion and occlusal examination.

Bogdan Oprea (2014)[59] According to his study the use of the T-Scan III system provides a better quality in the dental treatments providing information at a level of accuracy not obtained by conventional methods. From the economic point of view it becomes a "winning" solution allowing the elimination of several clinical technical stages. The duration of the treatment is usually reduced by 1-2 sessions, followed only by reassessments within the limits of the regular control methods. The software was found to be extremely easy, simple to use and understandable for someone with minimal knowledge of computer usage. Of course, the correct use of the information provided by the software requires a good training and an accurate understanding of the characteristic of functional and dysfunctional occlusion. The T-Scan III system paves the way for a study and research program, which is valuable for the occlusal analysis and balancing procedures.

MATERIALS AND METHODS

The subjects for this study were selected from the OPD, Department of Prosthodontics and Crown and Bridge, Tamil nadu government dental college and hospital, Chennai - 600003. This present study was performed to evaluate the occlusal discrepancies found in the fixed partial restorations both in pre-insertion and post-insertion stages. The functionally generated pathway technique is selected to fabricate the restorations and they were compared with restorations made by conventional casting methods.

ARMAMENTARIUM

INSTRUMENTS FOR EXAMINATION

1. Mouth mirror
2. Explorer
3. Periodontal probe
4. Kidney tray
5. Gloves
6. Mask
7. IOPA
8. OPG

FOR MAKING DIAGNOSTIC MODEL

1. Rubber Bowl and Alginate Spatula
2. Alginate
4. Stainless steel perforated dentulous rim lock trays
5. Dental stone
6. Dental plaster
7. Plaster spatula 8.Articulator

FOR TOOTH PREPARATION

1. Local Anaesthesia (lignocaine)
2. Diamond burs
3. Retraction cord
4. Putty elastomeric impression material
5. Light body elastomeric impression material
6. Tray adhesives
7. Spacer (cellophane Sheet)
8. Metal Stock trays
9. Bite registration wax
10. Autopolymerising resin (tooth coloured)

LAB PROCEDURE

1. Die stone
2. Die pin
3. Die cutting saw
4. Semi adjustable articulator
5. Die spacer
6. Inlay wax
7. Debubblizer
8. Casting ring
9. Investment material
10. Burnout machine
11. Casting machine
12. Metal pellets

13. Sand blasting machine
14. Metal trimmers
15. Micro motor
16. Pattern resin (GC Corp)
17. Cold mold seal
18. T-Scan armamentarium

SELECTION CRITERIA:

INCLUSION CRITERIA:

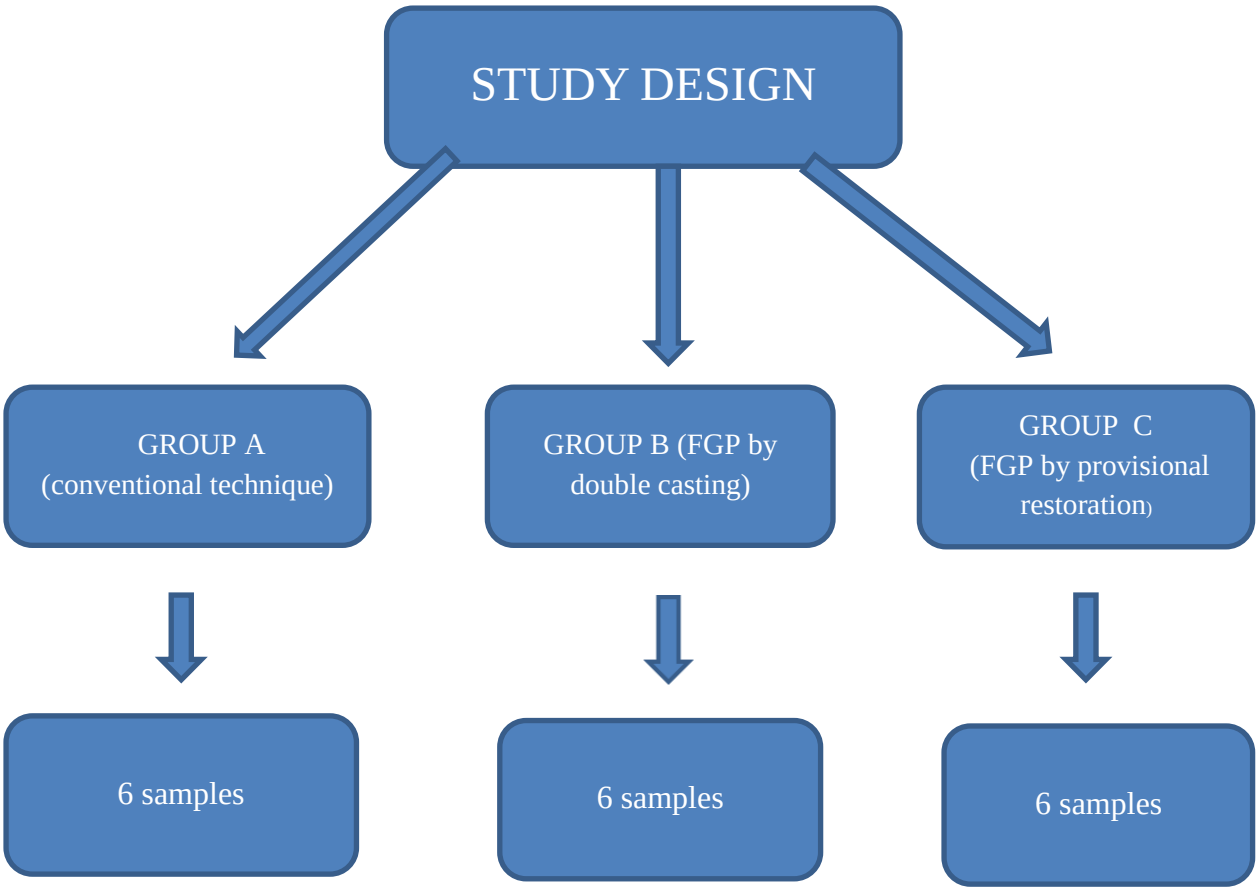
1. Patients requiring 3 unit posterior maxillary or mandibular fixed partial dentures for replacement of missing 1st molar (Unilateral or Bilateral).
2. Intact dentition opposing the edentulous space (any restoration if required was completed before the study was undertaken).
3. The incisal guidance should be acceptable, if not it should be corrected either by occlusal equilibration or by restorative procedures.
4. Elimination of posterior interferences and finally achieving good occlusal harmony
5. Presence of good periodontal health.
6. Both males and females selected were of age between 25 and 45 years.

EXCLUSION CRITERIA :

1. Loss of anterior guidance, which cannot be corrected without extensive restorative procedures
2. Multiple tooth missing (long span)
3. Poor periodontal health
4. Missing opposing teeth.
5. Medically compromised and debilitating patients.

6. Pregnant mothers
7. Mentally challenged patients
8. Rotated, supra erupted teeth
9. Recently extracted /unhealed edentulous space
10. Uncorrectable occlusal discrepancies
11. Teeth in cross bite
12. Patients having severely attrited teeth.
13. Patients lacking proper neuromuscular control
14. Patients having deep bite
15. Patients with history of orthodontic treatment
16. Patients having disharmony in occlusion and TMJ dysfunction

SAMPLE SIZE



SL NO	MATERIAL NAME	MANUFACTURER'S NAME
1	Alginate	(Vignette, Dentsply, India)
2	Polyvinyl Siloxane Putty Impression Material	(Aquasil, Dentsply, India)
3	Polyvinyl Siloxane Light Body Impression Material	(Aquasil, Dentsply, India)
4	Intermediate Restorative Material	(IRM, Dentsply, India)
5	Die Stone	(Kalrock®,KhalabhaiKarson Pvt Ltd, Mumbai, India).
6	Inlay Wax	(Uni wax, Normal,India)
7	Pattern Resin	(GC Corporation, Tokyo, Japan)
8	Investment Material	(Wirovest, Bego ,Germany)

9	**Retraction Cord**	**Ultrapack (#00) Displacement Cord Ultradent Products, USA)**
10	**Tooth Preparation Kit**	**(Shofu IAC Kyoto, Japan)**
11	**Airotor Hand Piece**	**(NSK, Nakanishi Inc, Japan)**
12	**Casting Machine**	**(Bego)**
13	**Micromotor**	**(Marathon, Japan)**
14	**Autopolymerising Resin (Tooth Coloured)**	**(Dpi, India)**
15	**T-Scan III Computerized Occlusal Analysis System**	**(Tekscan Inc., South Boston, MA USA)**

PLACE OF STUDY

1. Department of prosthodontics, Tamilnadu Government Dental College & hospital.
2. Best laser dental clinic, valasarawalkam, Chennai.

METHODOLOGY

STUDY DESIGN

Six patients, who required 3 unit fixed partial dentures for the replacement of their maxillary or mandibular posterior teeth were selected for the study. In each patient three methods of generating the occlusal morphology and two methods of castings were employed. Grouping was done based on the technique used for generating occlusal anatomy and casting.

Group A -- for evaluating the conventional wax pattern and casting technique,

Group B -- for evaluating the functionally generated occlusal morphology and a double casting technique.

Group C -- for evaluating the functionally generated occlusal morphology with provisional restoration technique and conventional casting

In the initial appointment, a preliminary impression was made using irreversible hydrocolloid impression material (Vignette, Dentsply, India) and the diagnostic casts were mounted on a semi adjustable articulator (C.S.A 600 Articulator,Corident Co., Ltd) using a face-bow transfer (Cori Facebow, Corident Co., Ltd.). Centric and Protrusive records were made using Aluwax. The patient was trained to close in maximum intercuspation (MIP) and perform various other eccentric movements. [Right lateral (RL) left lateral (LL) and protrusive (P)].

METHODS

After proper examination and analysis, premature contacts were eliminated and occlusal harmony was established and finally it was verified with T–Scan. It was verified whether the bite force readings on both sides were almost equal. The clusion and disclusion time also was evaluated and was made to approach the values close to the normal range.

TOOTH PREPARATION

Two putty index of the diagnostic cast were made involving the missing tooth to be replaced and the adjacent two teeth on either side. One for verification of abutment tooth reduction and another one for fabrication of provisional restoration. Under local anaesthesia, tooth preparation was done with diamond burs and airotor hand piece after depth orientation grooves were made. Reductions of the occlusal and facial surfaces were done to 1.5mm and 1mm on the lingual and proximal surfaces. Equigingival margins of shoulder with bevel is made in the facial aspect, chamfer margins in proximal and lingual aspects were made. Twisted Retraction cord was (Ultrapack (#00) Displacement Cord Ultradent Products, USA) placed and subsequently 2 stage putty and light body impression technique was followed. Two such impressions were taken, one for the fabrication of the provisional restoration and one for the fabrication of wax pattern and castings. Casts were poured with die stone and later die pins were placed, base were made and die preparation was done.

FABRICATION OF RESTORATIONS

CONVENTIONAL METHOD

Face bow transfer was done and maxillary cast mounted in the articulator, mandibular cast was articulated in the semi adjustable articulator according to centric interocclusal record using Aluwax. Programming of articulator was done using centric and protrusive interocclusal records.

Die spacer was applied to the prepared teeth and wax pattern was fabricated using Inlay wax in the conventional manner, with normal occlusal anatomy made in the semi adjustable articulator which will be later carved and finished. Wax pattern was sprued, invested and casting was done in the conventional manner. The castings were divested, sandblasted with 50µm alumina after the sprues were cut. They were subsequently trimmed with the metal

trimmers and polishing done with the polishing kit and rouge. The finished castings were inserted in the patient's mouth for fit and accuracy.

ESTABLISHMENT OF FUNCTIONALLY GENERATED PATH USING DOUBLE CASTING METHOD

Wax patterns were fabricated in infraocclusion of 0.5 to 1 mm and retention beads were attached on the occlusal surfaces of wax pattern for aiding in the retention of the pattern resin during functional generation of the occlusal morphology.

Wax Pattern was sprued, invested and casting was done. Later it was trimmed and finished. The base crowns were verified for accuracy of fit and proximal contacts on the models and in the mouth. Any adjustments needed to ensure the fit were made.

Autopolymerising pattern resin (GC corp) was mixed according to manufacturer's instructions and applied to the occlusal surfaces of base crown fit with retentive beads on the prepared tooth to make experimental occlusal surfaces. The patient was asked to perform movements starting from maximum intercuspation, then right and left lateral, protrusive movements and finally ending in maximum intercuspation. The cusps of the lower posterior teeth function like styli and thus create a three dimensional record of all basic mandibular movements in the autopolymerizing pattern resin. The base metal crowns which act like metal trays with the pattern resin are removed from the mouth and reseated on the master cast. The excess pattern resin was trimmed off using an acrylic trimmer. The occlusal surfaces were examined for any exposure of the metal. If present, the metal in the area was trimmed, pattern resin was added in that area and movements were performed once again. The greatest problem encountered while developing the functionally generated path is to be certain that the mandible returns to the accurate centric relation.

The pattern along with the base casting was invested and doubles casting done. The double cast specimens were placed on abutment after trimming, finishing and polishing.

ESTABLISHMENT OF FUNCTIONALLY GENERATED PATH USING PROVISIONAL RESTORATION

In the study model the denture tooth was placed in wax in the edentulous area and putty index was made. The index was used to fabricate the provisional restoration on the model after the preparation of teeth with tooth coloured autopolymerising resin. The occlusal surface of the provisional restoration was made short of contacts with the opposing tooth and verified in the patient's mouth. After addition of autopolymerising resin in the dough stage onto the occlusal surface of the restoration, the patient was asked to perform movements starting from maximum intercuspation, then right and left lateral, protrusive movements and finally ending in maximum intercuspation until the materials sets. Trimming, polishing was done after verification of occlusal morphology, the provisional restoration was cemented with intermediate restorative material. After 2 weeks, a second provisional restoration was made ready and the previous one was removed from the patient's mouth and second provisional was cemented.

The removed provisional restoration was examined and cement was removed and cleaned with ultrasonic cleaner. It was subsequently sprued, invested and cast with non precious Ni-Cr alloy. The casting was divested, trimmed and polished and placed in patient's mouth.

The occlusal harmonies of the restorations fabricated by the three different methods were evaluated by T-Scan using clusion and disclusion time. The readings were recorded and subjected to statistical analysis.

Statistical analyses used are

Wilcoxon Signed Ranks Test

Friedman Test ,Descriptive statistics mean & S.D

USE OF T-SCAN

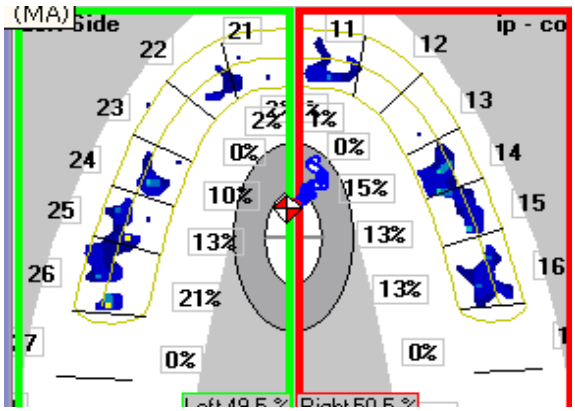
For properly applying this technique we must first ask the patient to relax and then educate them to bite in the most repeatable centric and eccentric positions. As an initial step, the occlusal discrepancy in the existing normal dentition is evaluated after thorough diagnosis and treatment planning and it is recorded with the help of T-Scan. This gives us the picture of premature contacts or interferences which must be removed to establish a harmonious occlusion. Next the patient is asked to bite on the sensor and verified for any remaining occlusal problems. Now it is found that it is almost fully eliminated on both the sides of the natural dentition and clusion and disclusion time were evaluated and it was brought to reach almost the normal values. These readings were saved in the computer which will be used as a future reference for analysing occlusal discrepancies after the restorative phase.

The restorations fabricated using the conventional technique, functionally generated path using double casting technique and the restorations made using provisional restoration technique were placed in the patient's mouth and the clusion and disclusion time values were obtained. These values were compared with that of the pre-existing occlusion and that between the three restorations.

The sensor used here helps to obtain reliable measurements of occlusal biting forces on individual tooth by recording the sequence force, and timing of contact quantitatively. The sensor device is licensed as a "medical attachment device– contact sensor system". The sensor foils used have a layer thickness of 100 μm and are hence within the range of commercially available articulating foils, papers and silk (8–200μm).

A grid of conductive lines is embedded in the sensor foils. Voltage drops in the conductive lines result from any force exerted on the foil. These voltage changes are measured and digitalized by the T-Scan® software.

2-D Columns: displays the pressures as a two-dimensional, contoured image, with differences in occlusal force represented by colors ranging from red (greatest) to blue (lowest)



2-D COLUMNS

According to Qudeer et al multiple numbers of readings can be taken to get a correct value of bite force of the individual during the preliminary investigations.

CLUSION TIME

It is found that the time elapsed from the 1st contact to the complete occlusal interdigitation should be ideally zero or as minimum as possible, but achieving this clinically is impossible without the use of T-scan which gives us the sequence, time and duration of individual tooth contacts. So we keep the time frame of 0.1- 0.3 sec as standard in our study as it is also easier to achieve clinically.

DISCLUSION TIME

This time should be within the range of < 0.5 sec as the patients selected were free of TMJ dysfunction, jaw discrepancies and were having good neuromuscular coordination. The significance of this posterior disclusion time is that when it is prolonged it leads to elevated muscle contractions in masseter and temporalis muscles. An attempt should be made to keep it to the minimum to reduce these muscle contractions and keep them in the resting state as far as possible.

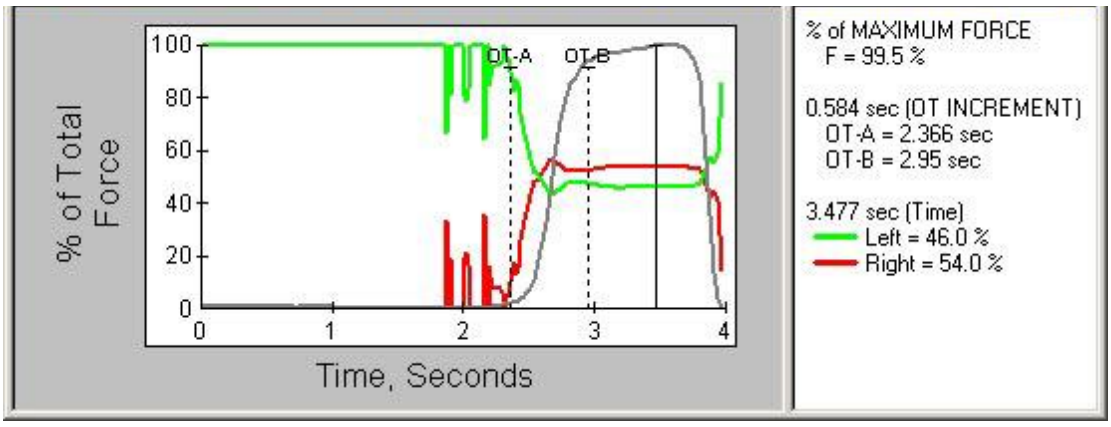
RECORDING OF CLUSION AND DISCLUSION TIME

The patient is asked to relax and then bite in the most repeatable centric and eccentric positions. The time elapsed from the 1st contact to the complete occlusal interdigitation is the clusion time and is shown in the graph as converging force lines show a static, non changing force represented by horizontal lines. The amount of Clusion time starts from the start of the "A" Line ends at "B" Line and is recorded in seconds. Now the patient is asked to perform right lateral, left lateral and protrusive movements and the force lines start diverging as the patient makes an excursive movement. C-D Increment lines can be used to denote the start and end of the Disclusion Time.

INTERPRETATION OF FULL CLOSURE GRAPH

This graph illustrates the converging force changes occurring as the patient closes in the MIP or CR. These converging force lines show a static, non changing force represented by horizontal lines. This is a representation when the mandible remains static and fixed against the maxilla during the time of static interdigitation.

The 2 quadrant force plot describes the force changes that occur during the force movie in the 2 halves of the dental arch

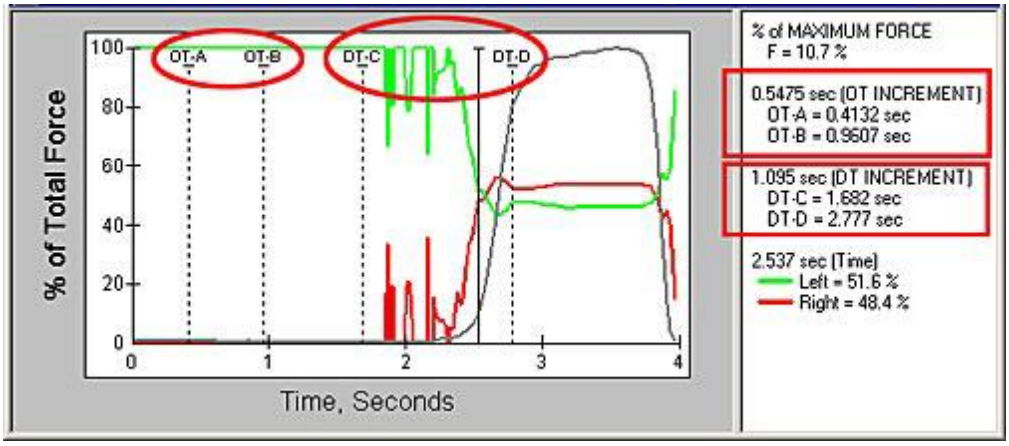


FORCE Vs TIME GRAPH IN CLUSION TIME RECORDING

The amount of Clusion time starts from the start of the "A" Line (OT-A) ends at "B" Line (OT-B), in seconds. The A-B Increment/Differential lines can be used to denote the start and end of the clusion Time (OT-A and OT-B). As the operator moves the A-B lines to their chosen locations, the software simultaneously computes the elapsed time and displays it in the graph box to aid in easy interpretation.

INTERPRETATION OF AN EXCURSIVE GRAPH

In this graph also the converging force changes occurring as the patient closes in the MIP or CR are seen but they start diverging as the patient makes an excursive movement. Here the mandibular closure precedes the start of excursion. After recording the Force movie, a Force Vs Time graph gets displayed and the C-D Increment/Differential lines can be used to denote the start and end of the Disclusion Time (DT-C and DT-D).



FORCE Vs TIME GRAPH IN DISCLUSION TIME RECORDING

The 4 quadrant graph illustrates force changes anteroposteriorly as well as mediolaterally.

SIGNIFICANCE OF A-B LINES

The time elapsed from the 1st contact to the complete occlusal interdigitation should be within the range of 0.1 - 0.3 sec which illustrates that both the halves of the dental arch function simultaneously and harmoniously.

SIGNIFICANCE OF C-D LINES

Aid to determine the effectiveness of anterior guidance in posterior disclusion by calculating the posterior disclusion time.

Prolonged posterior Disclusion Time (>.5 seconds per excursion) has been determined to be etiologic for Myofascial Pain Dysfunction Syndrome (MPDS). The shorter the duration of the elapsed posterior Disclusion Time, the faster the Anterior Guidance takes complete control over excursive function.

Photo 1: Materials and armamentarium used during diagnostic stage

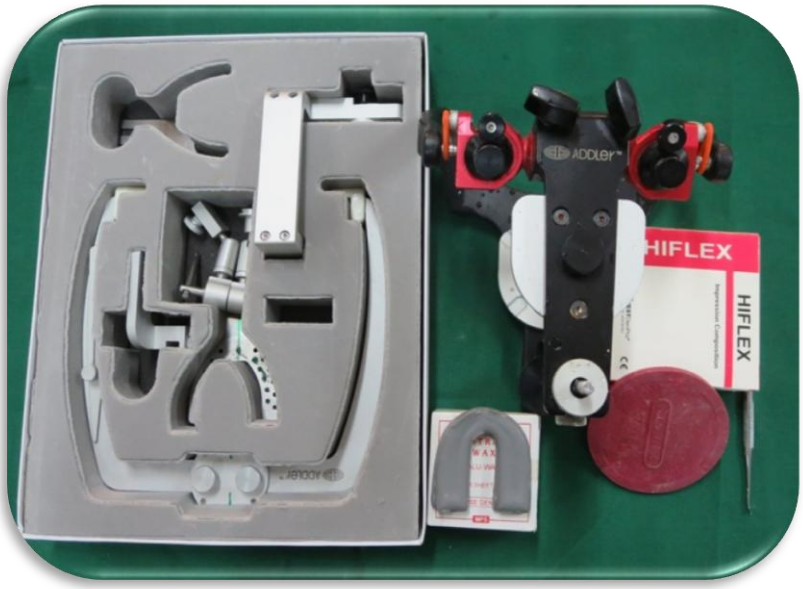


Photo 2: Materials and armamentarium used during diagnostic mounting and face bow transfer

Photo 3: Materials and armamentarium used during tooth preparation, impression and temporization

Photo 4: Materials and armamentarium used during die preparation, wax and resin pattern fabrication and casting

Photo 5: Pre operative intra oral view - frontal

Photo 6: Pre operative intra oral view – occlusal

Photo 7: Diagnostic articulation

Photo 8: Occlusal view after tooth prepation

Photo 9: Placement of retraction cord

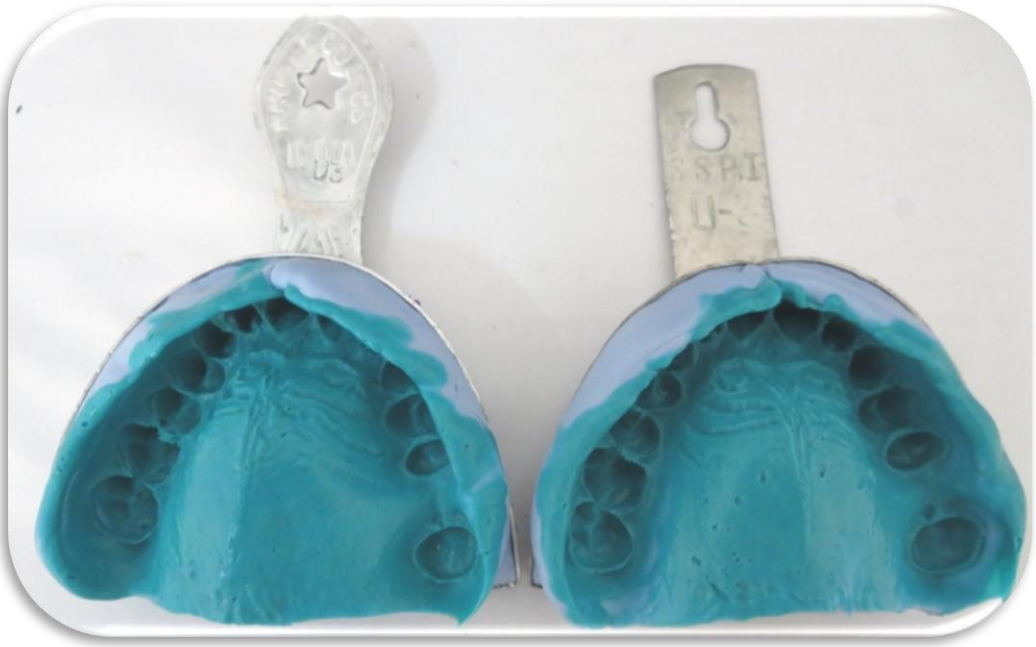


Photo 10: Final impression

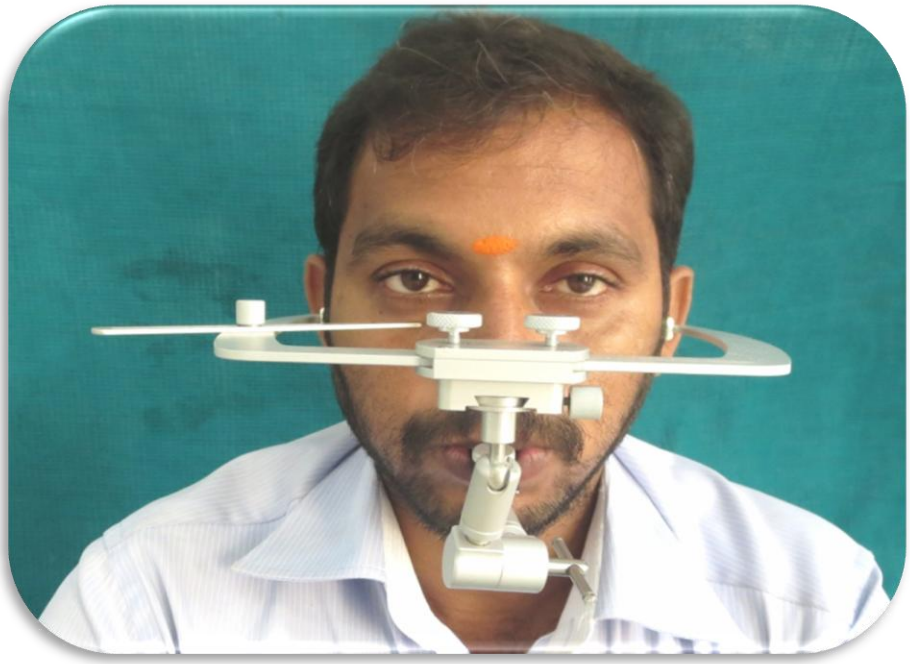


Photo 11: Face bow transfer

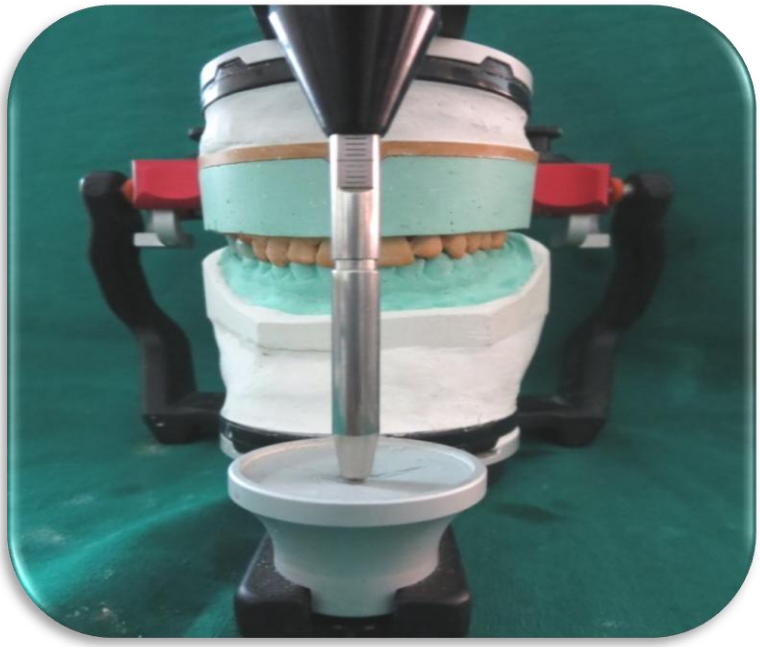


Photo 12: Articulation done for fabrication of restoration

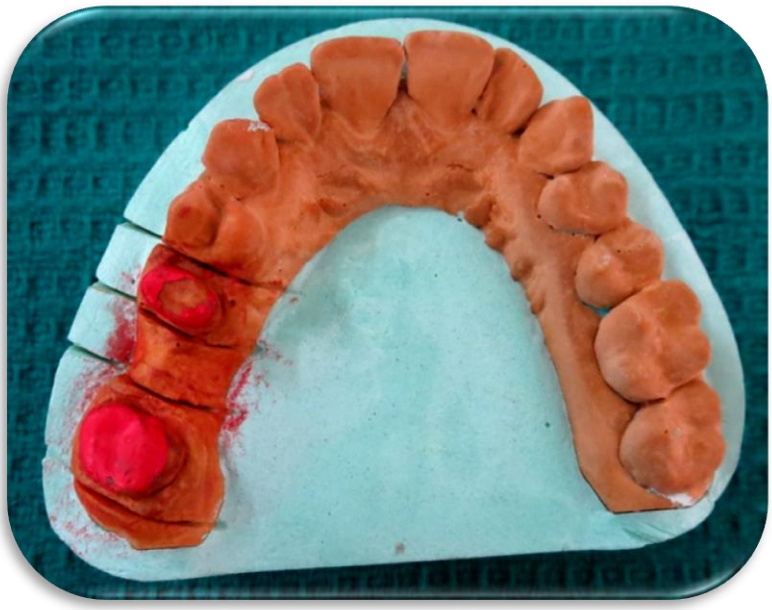


Photo 13: Die preparation and die spacer application

Photo 14: Artificial tooth placed for fabrication of provisional restoration

Photo 15: Making putty index

Photo 16

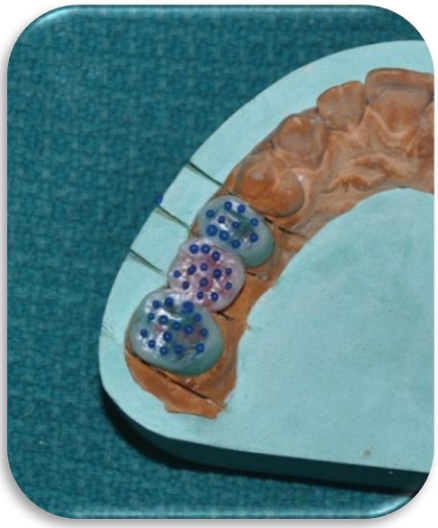


Photo 17

Wax patterns before casting

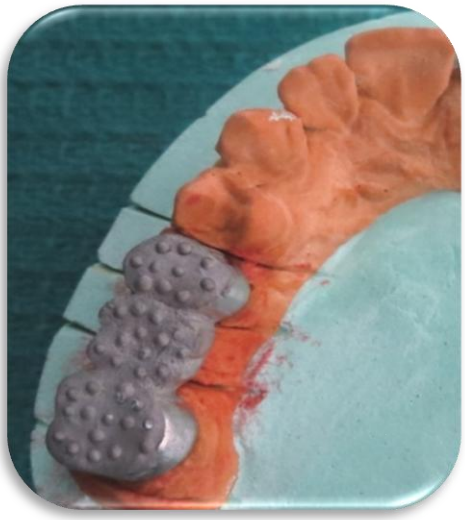


Photo 18

Photo 19

Base crowns for FGP

Photo 20

Photo 21

Photo 22

Steps in fabrication of FGP by double casting

Photo 23

Photo 24

Photo 25

Fabrication of provisional restoration by FGP

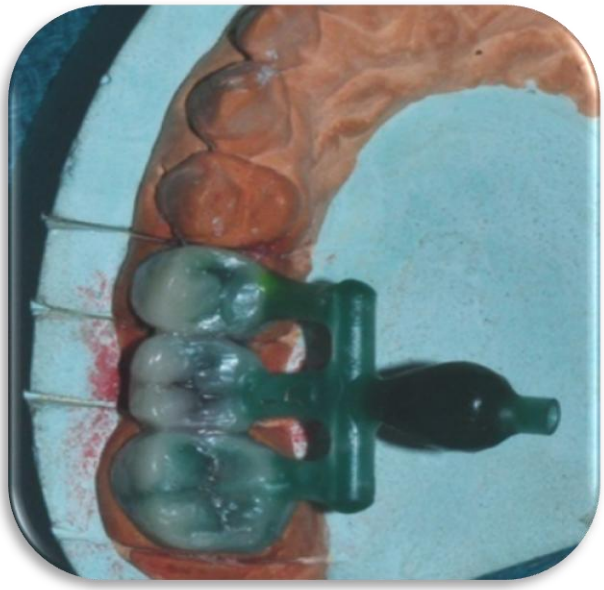


Photo 26

Photo 27

Photo 28

Sprue placement

Photo 29: Cetrifugal casting machine used in the study

Photo 30

Photo 31

Photo 32

Photo 33

Restorations during trial in the mouth

Photo 34: Sensor foil **Photo 35: T-Scan**

Photo 36: Obtaining readings in T-Scan

FIG.1. CENTRIC RELATION - PREEXISTING

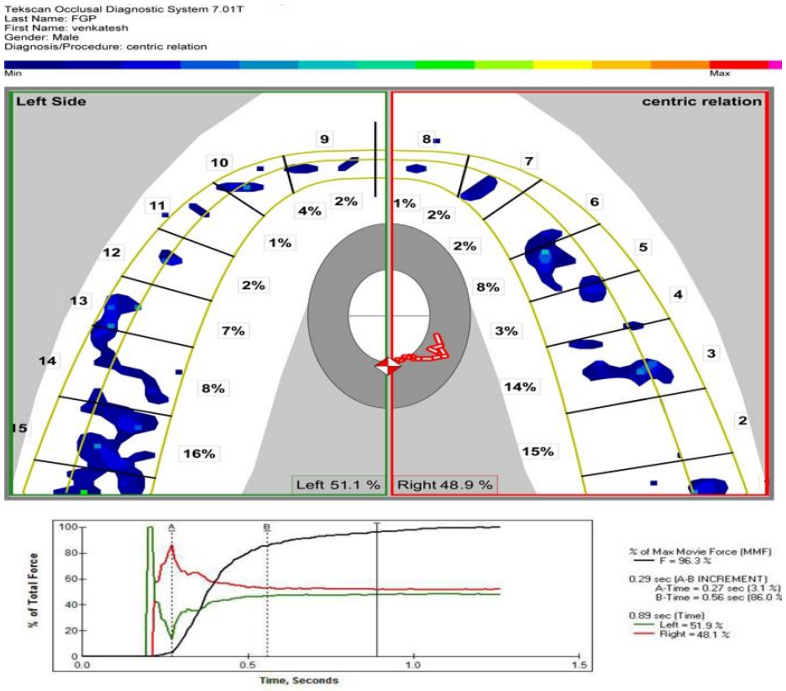


FIG.2. CENTRIC RELATION - CONVENTIONAL

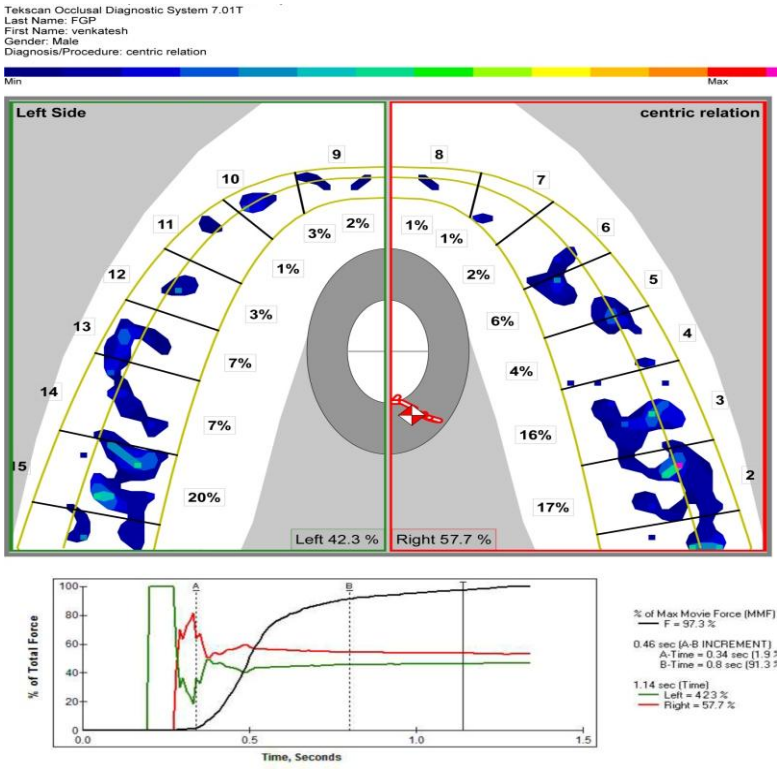


FIG.3.CENTRIC RELATION - DOUBLE CASTING

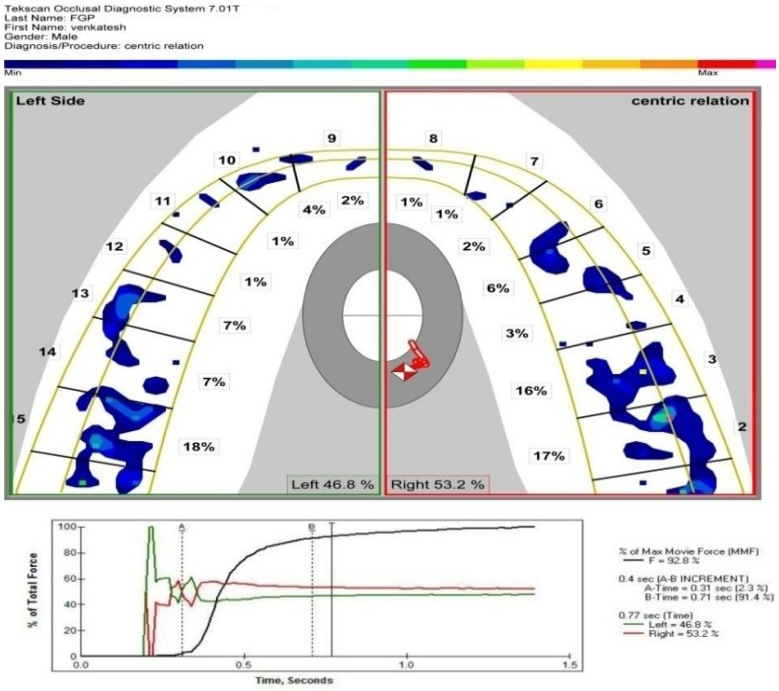


FIG.4.CENTRIC RELATION - PROVISIONAL

RESTORATION

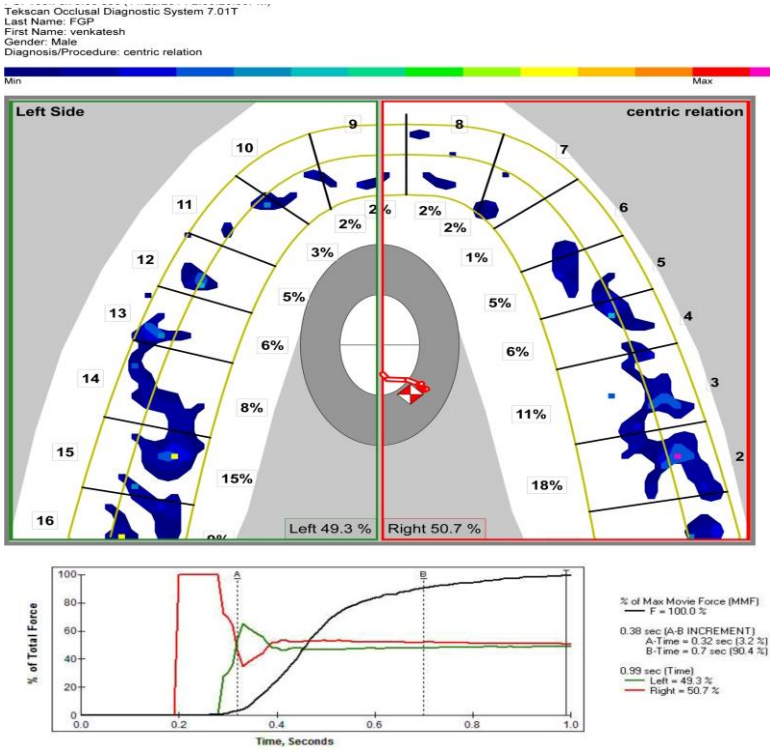


FIG.5. RIGHT LATERAL – PREEXISTING

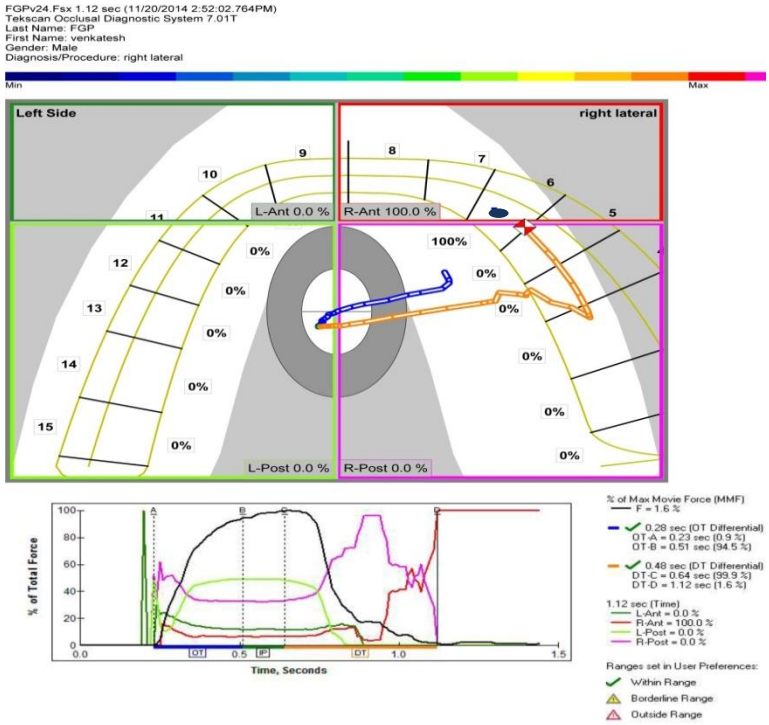


FIG.6.RIGHT LATERAL - CONVENTIONAL

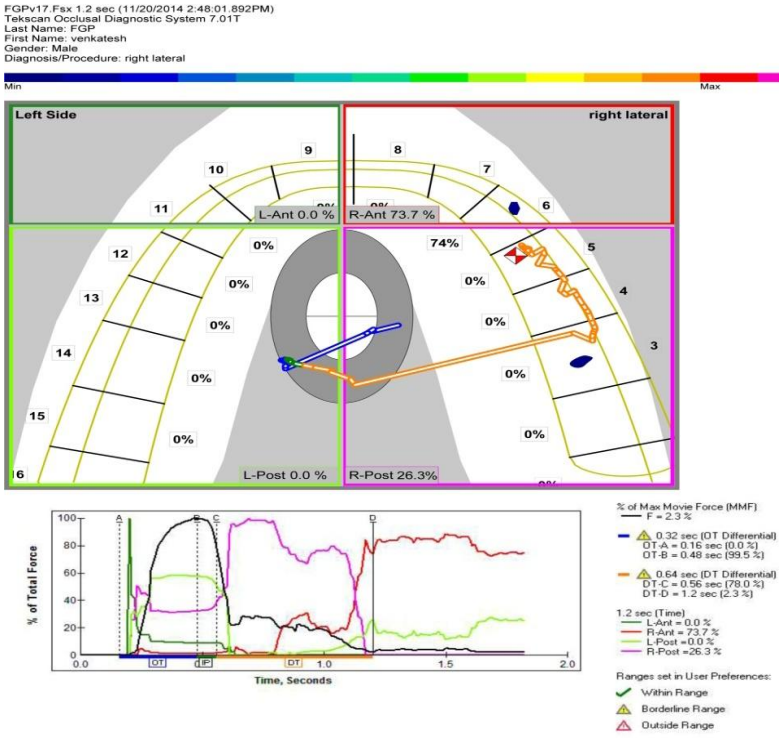


FIG.7.RIGHT LATERAL - DOUBLE CASTING

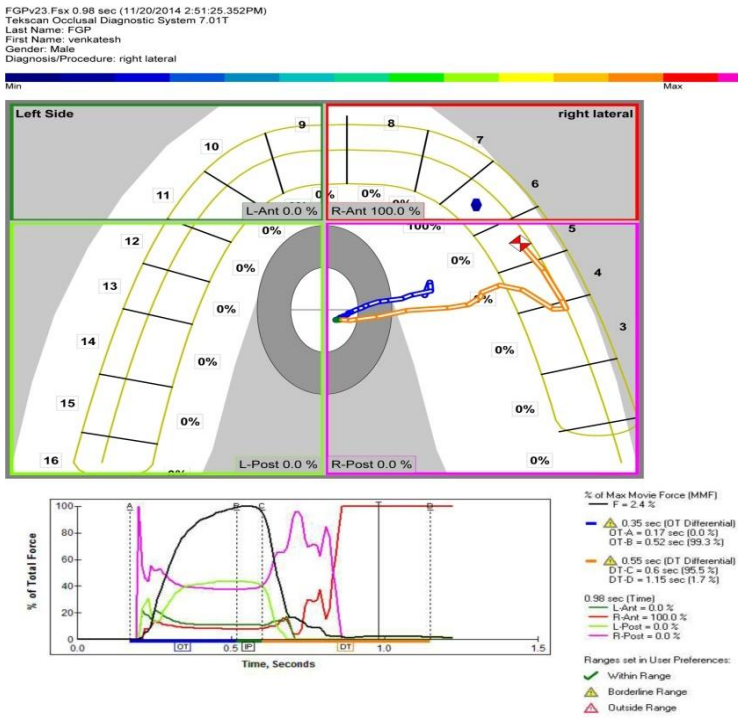


FIG.8.RIGHT LATERAL - PROVISIONAL

RESTORATION

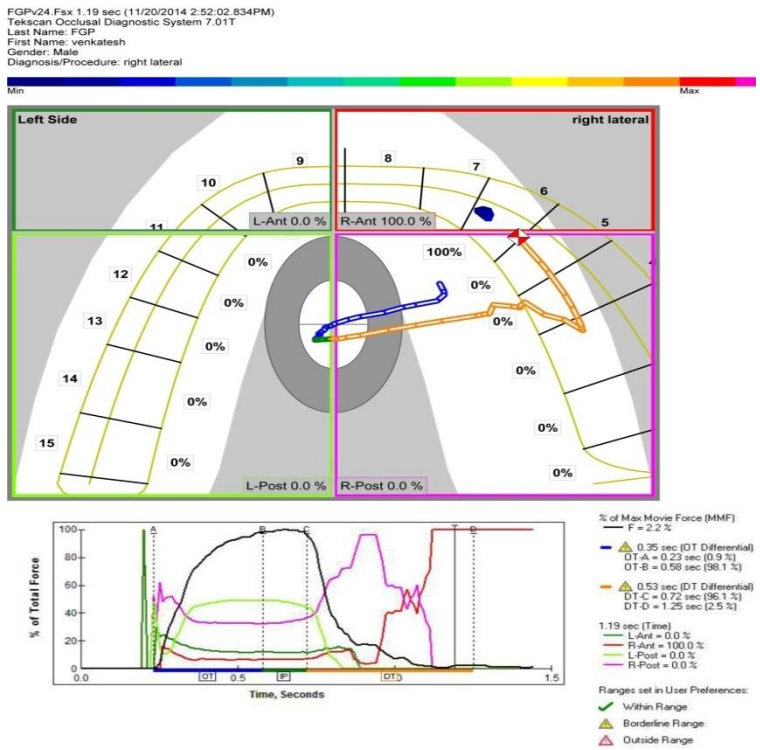


FIG.9.LEFT LATERAL - PREEXISTING

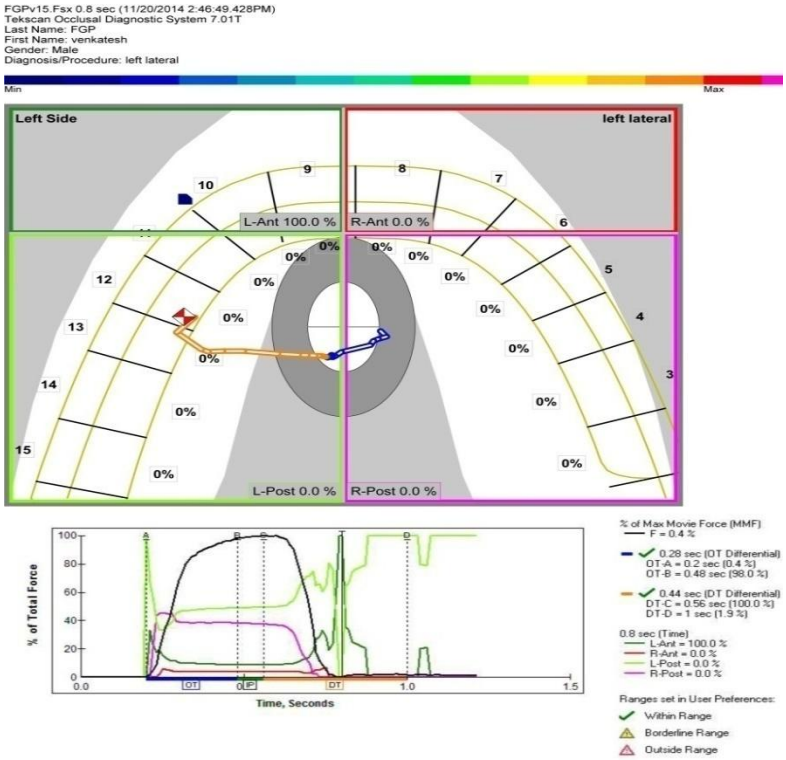


FIG.10.LEFT LATERAL - CONVENTIONAL

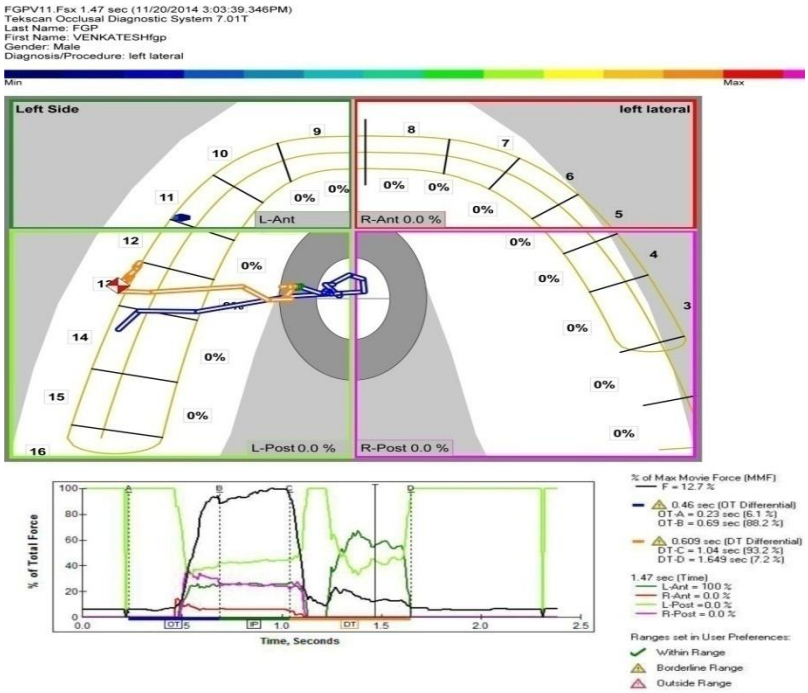


FIG.11. LEFT LATERAL - DOUBLE CASTING

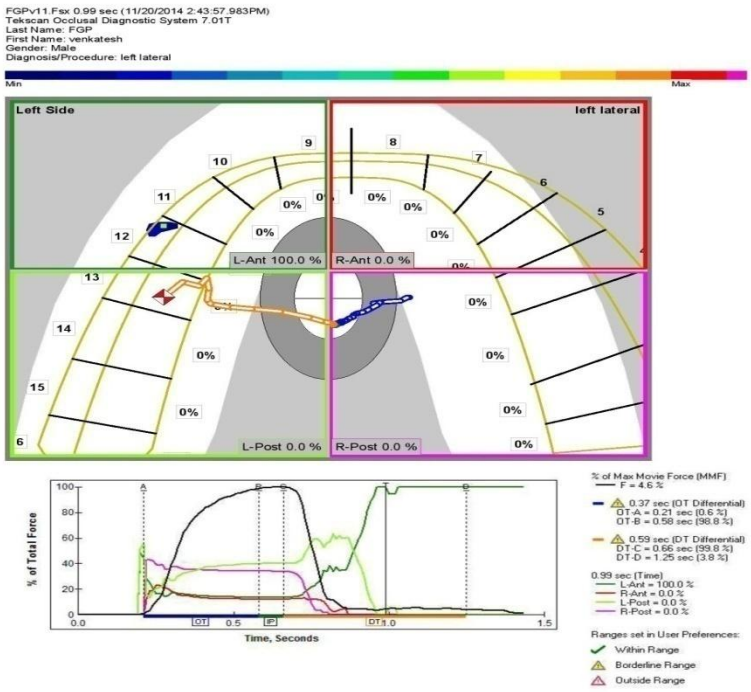


FIG.12.LEFT LATERAL - PROVISIONAL

RESTORATION

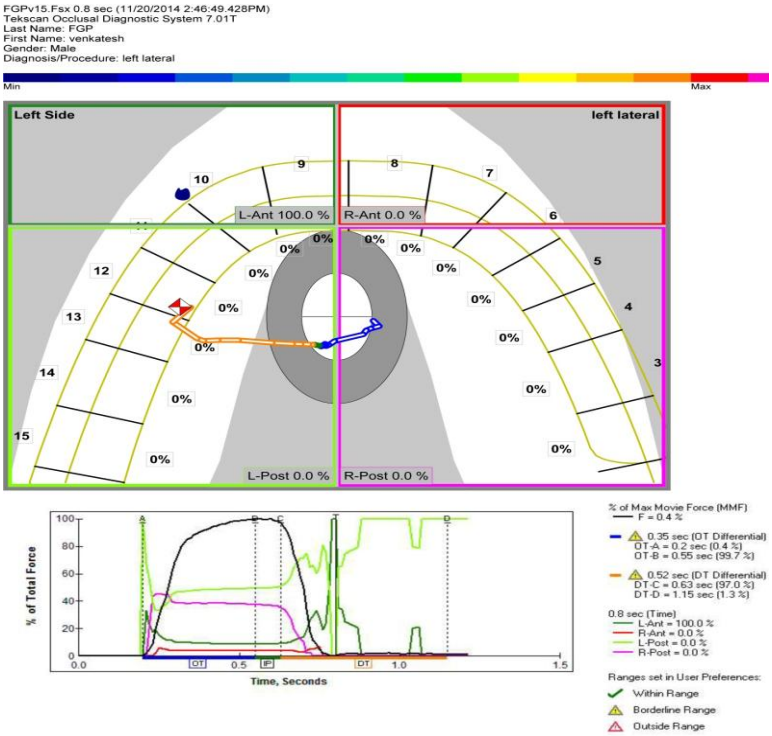


FIG.13.PROTRUSION - PRE EXISTING

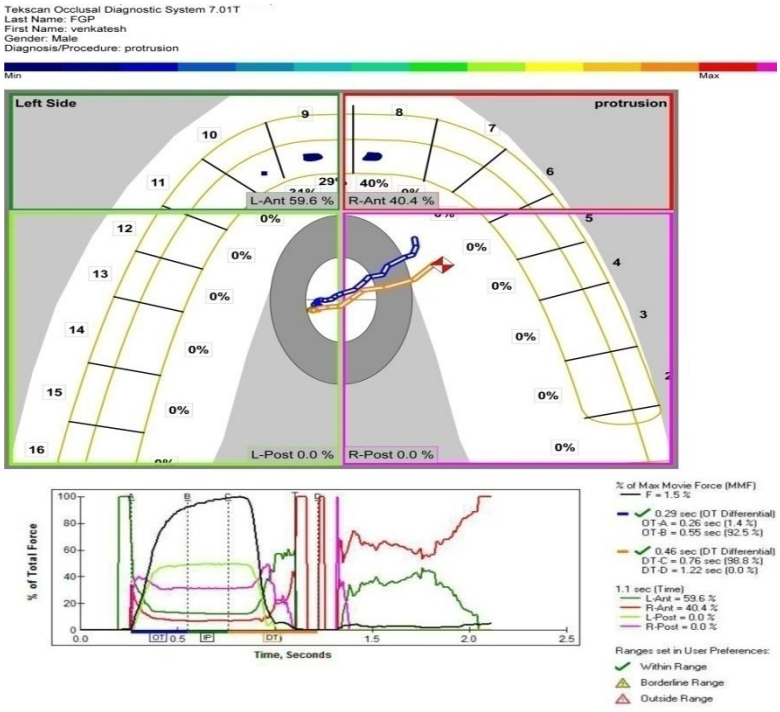


FIG.14.PROTRUSION - CONVENTIONAL

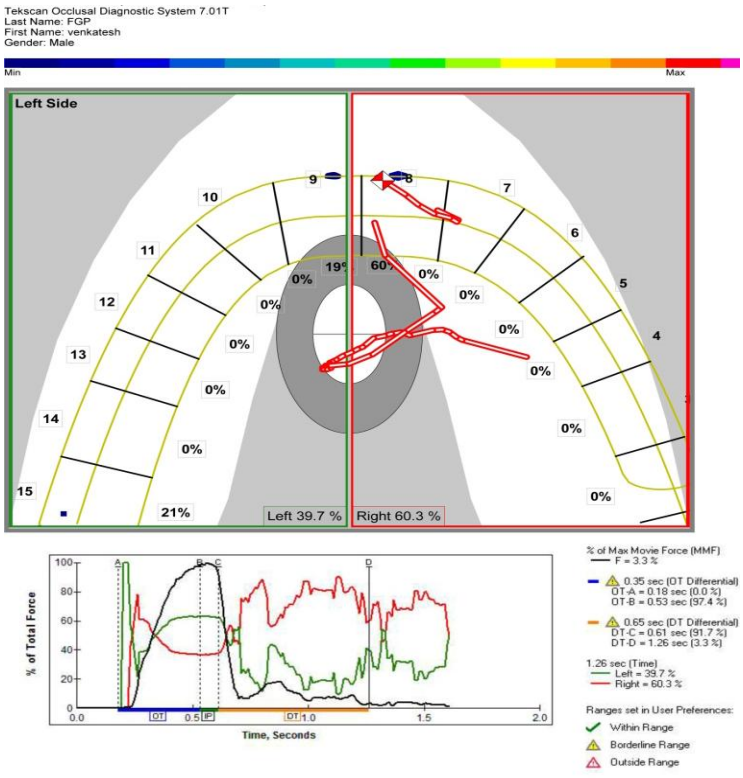


FIG.15.PROTRUSION - DOUBLE CASTING

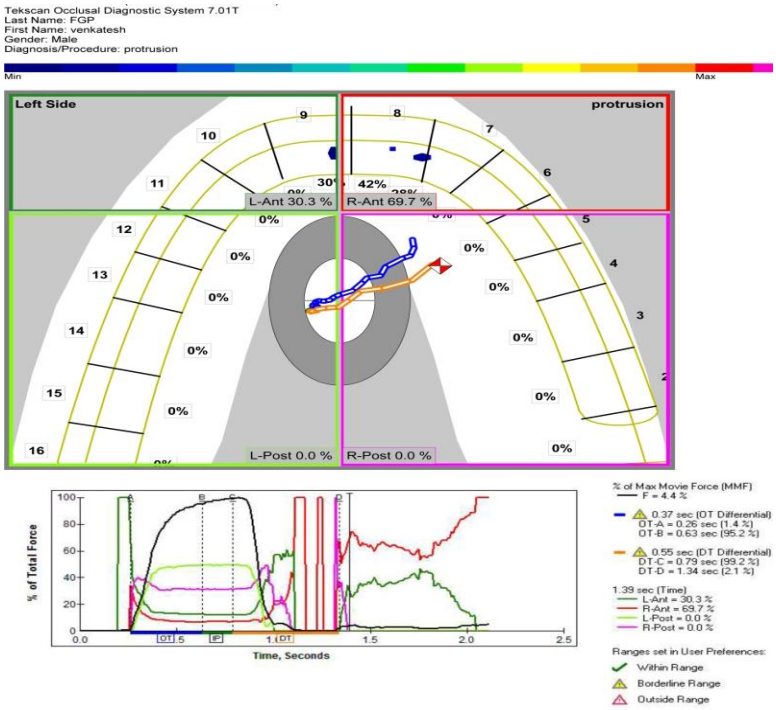
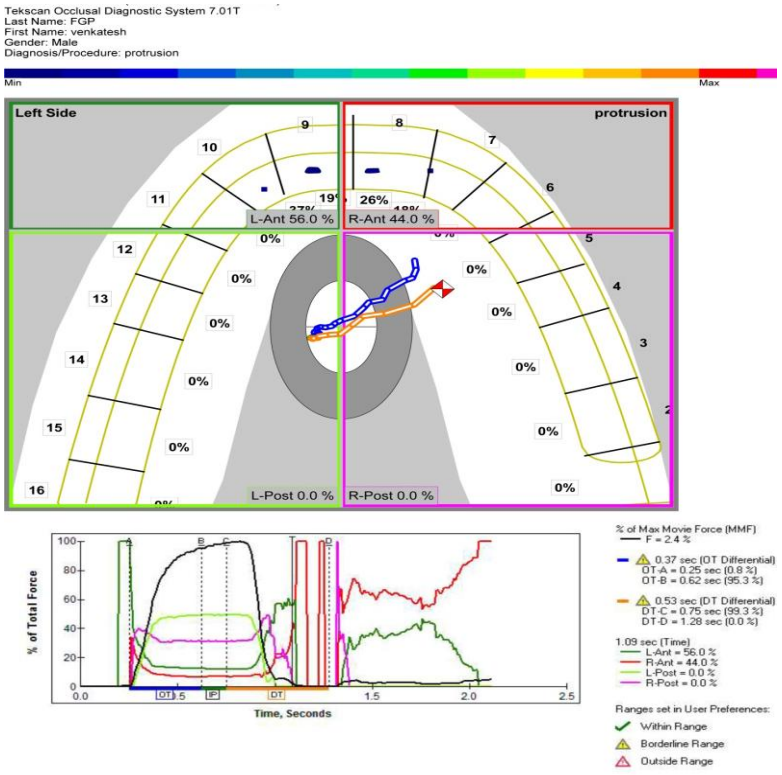


FIG.16.PROTRUSION - PROVISIONAL

RESTORATION



RESULTS

The collected data was analysed with SPSS 16.0 version. To describe about the data descriptive statistics mean and S.D were used. To find the significant difference between the bivariate samples in Paired groups (PRE with CT, DCT & FGP) Wilcoxon signed rank test was used and for repeated measures (CT, DCT & FGP) the Friedman test was used. In both the above statistical tools the probability value 0.05 is considered as significant level. Z value obtained in this study is the absolute value obtained during comparison between the values in Wilcoxon signed rank test. It is found that as Z value increases, P value decreases and the level of significance increases.

TEST STATISTICS

TABLE 1 - ON MAXIMUM INTERCUSPATION WITH PREEXISTING

Wilcoxon Signed Ranks Test

MAXIMUM INTERCUSPATION	Z value	P value
CT – PRE	2.201	0.028
DCT – PRE	2.032	0.042
FGP – PRE	2.201	0.028

TABLE 2 - ON MAXIMUM INTERCUSPATION BETWEEN RESTORATIONS

MAXIMUM INTERCUSPATION	Z value	P value
DCT – CT	2.201	0.028
FGP – CT	2.207	0.027
FGP – DCT	0.000	1.000

TABLE 3 - LATERAL EXCURSION ON RESTORATIVE SIDE WITH PREEXISTING

RESTORATIVE SIDE	Z value	P value
CTRS – PRERS	2.201	0.028
DCTRS - PRERS	1.992	0.046
FGPRS - PRERS	2.207	0.027

TABLE 4 - LATERAL EXCURSION ON NORMAL SIDE WITH PREEXISTING

NORMAL SIDE	Z value	P value
CTNS – PRENS	2.207	0.027
DCTNS – PRENS	1.572	0.116
FGPNS – PRENS	1.363	0.173

TABLE 5 - ON PROTRUSIVE EXCURSION WITH PREEXISTING

ON PROTRUSION	Z value	P value
CTP – PREP	2.207	0.027
DCTP – PREP	1.992	0.046
FGPP – PREP	1.992	0.046

TABLE 6 - LATERAL EXCURSION ON RESTORATIVE SIDE BETWEEN RESTORATIONS

RESTORATIVE SIDE	Z value	P value
DCTRS – CTRS	2.207	0.027
FGPRS – CTRS	2.201	0.028
FGPRS – DCTRS	0.318	0.750

TABLE 7 - LATERAL EXCURSION ON NORMAL SIDE BETWEEN RESTORATIONS

NORMAL SIDE	Z value	P value
DCTNS – CTNS	2.201	0.028
FGPNS – CTNS	2.207	0.027
FGPNS – DCTNS	0.843	0.399

TABLE 8 - ON PROTRUSIVE EXCURSION BETWEEN RESTORATIONS

ON PROTRUSION	Z value	P value
DCTP – CTP	2.032	0.042
FGPP – CTP	2.201	0.028
FGPP – DCTP	0.315	0.752

DESCRIPTIVE STATISTICS

TABLE 9 - MULTIPLE COMPARISONS USING FRIEDMAN TEST ON MAXIMUM INTERCUSPATION

MAXIMUM INTERCUSPATION	N	Mean	Std. Deviation	P- value
PRE	6	0.298	0.063	
CT	6	0.616	0.116	0.009
DCT	6	0.411	0.071	
FGP	6	0.410	0.068	

TABLE 10 - MULTIPLE COMPARISONS USING FRIEDMAN TEST FOR LATERAL EXCURSION ON RESTORATIVE SIDE

RESTORATIVE SIDE	N	Mean	Std. Deviation	P- value
PRERS	6	0.478	0.091	
CTRS	6	0.805	0.124	0.009
DCTRS	6	0.550	0.089	
FGPRS	6	0.540	0.068	

TABLE 11 - MULTIPLE COMPARISONS USING FRIEDMAN TEST FOR LATERAL EXCURSION ON RESTORATIVE SIDE

NORMAL SIDE	N	Mean	Std. Deviation	P – value
PRENS	6	0.461	0.067	
CTNS	6	0.753	0.142	0.009
DCTNS	6	0.516	0.048	
FGPNS	6	0.501	0.024	

TABLE 12 - MULTIPLE COMPARISONS USING FRIEDMAN TEST ON PROTRUSION

ON PROTRUSION	N	Mean	Std. Deviation	P- value
PREP	6	0.496	0.073	
CTP	6	0.720	0.084	0.015
DCTP	6	0.566	0.102	
FGPP	6	0.571	0.034	

TABLE 1:

1. The difference in clusion time between the restoration fabricated using conventional technique when compared with the preexisting occlusion were found to have a Z value of 2.201 and the difference was significant (P=0.028)

2. The difference in clusion time between the restoration fabricated using functionally generated double casting technique when compared with the preexisting occlusion were found to have a Z value of 2.032 and the difference was significant (P=0.042)

3. The difference in clusion time between the restoration fabricated using functionally generated provisional restoration technique when compared with the preexisting occlusion were found to have a Z value of 2.201 and the difference was significant (P=0.028)

TABLE 2:

1. The difference in clusion time between the restoration fabricated using conventional technique when compared with the functionally generated double casting technique occlusion were found to have a Z value of 2.201 and the difference was significant (P=0.028)

2. The difference in clusion time between the restoration fabricated using conventional technique when compared with the functionally generated provisional restoration technique occlusion were found to have a Z value of 2.207 and the difference was significant (P=0.027)

3. The difference in clusion time between the restoration fabricated using functionally generated provisional restoration technique when compared with the functionally generated double casting technique occlusion were found to have a Z value of 0.00 and the difference was not significant (P=1)

TABLE 3:

1. The difference in disclusion time on lateral excursion in the restorative side between the restoration fabricated using conventional technique when compared with the preexisting occlusion were found to have a Z value of 2.201 and the difference was significant (P=0.028)

2. The difference in disclusion time on lateral excursion in the restorative side between the restoration fabricated using functionally generated double casting technique when compared with the preexisting occlusion were found to have a Z value of 1.992 and the difference was significant (P=0.046)

3. The difference in disclusion time on lateral excursion in the restorative side between the restoration fabricated using functionally generated provisional restoration technique when compared with the preexisting occlusion were found to have a Z value of 2.207 and the difference was significant (P=0.027)

TABLE 4:

1. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using conventional technique when compared with the preexisting occlusion were found to have a Z value of 2.207 and the difference was significant (P=0.027)

2. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using functionally generated double casting technique when compared with the preexisting occlusion were found to have a Z value of 1.572 and the difference was not significant (P=0.116)

3. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using functionally generated provisional restoration technique when compared with the preexisting occlusion were found to have a Z value of 1.363 and the difference was not significant (P=0.173)

TABLE 5:

1. The difference in disclusion time on protrusion between the restoration fabricated using conventional technique when compared with the preexisting occlusion were found to have a Z value of 2.207 and the difference was significant (P=0.027)

2. The difference in disclusion time on protrusion between the restoration fabricated using functionally generated double casting technique when compared with the preexisting occlusion were found to have a Z value of 1.992 and the difference was significant (P=0.046)

3. The difference in disclusion time on protrusion between the restoration fabricated using functionally generated provisional restoration technique when compared with the preexisting occlusion were found to have a Z value of 1.992 and the difference was significant (P=0.046)

TABLE 6:

1. The difference in disclusion time on lateral excursion in the restorative side between the restorations fabricated using conventional technique and functionally generated double casting technique were found to have a Z value of 2.207 and the difference was significant (P=0.027)

2. The difference in disclusion time on lateral excursion in the restorative side between the restorations fabricated using conventional technique and functionally generated provisional restoration technique were found to have a Z value of 2.201 and the difference was significant (P=0.028)

3. The difference in disclusion time on lateral excursion in the restorative side between the restorations fabricated using functionally generated double casting technique and functionally

generated provisional restoration technique were found to have a Z value of 0.318 and the difference was not significant (P=0.750)

TABLE 7:

1. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using conventional technique and functionally generated double casting technique were found to have a Z value of 2.201 and the difference was significant (P=0.028)

2. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using conventional technique and functionally generated provisional restoration technique were found to have a Z value of 2.207 and the difference was significant (P=0.027)

3. The difference in disclusion time on lateral excursion in the normal side between the restorations fabricated using functionally generated double casting technique and functionally generated provisional restoration technique were found to have a Z value of 0.843 and the difference was not significant (P=0.399)

TABLE 8:

1. The difference in disclusion time on protrusion between the restorations fabricated using conventional technique and functionally generated double casting technique were found to have a Z value of 2.032 and the difference was significant (P=0.042)

2. The difference in disclusion time on protrusion between the restorations fabricated using conventional technique and functionally generated provisional restoration technique were found to have a Z value of 2.201 and the difference was significant (P=0.028)

3. The difference in disclusion time on protrusion between the restorations fabricated using functionally generated double casting technique and functionally generated provisional

restoration technique were found to have a Z value of 0.315 and the difference was not significant (P=0.752)

TABLE 9:

This test shows that the comparison between the three types of restorations in the maximum intercuspation is highly statistically significant with P value of $0.009 \leq 0.01$

TABLE 10:

This test shows that the comparison between the three types of restorations in the restorative side is highly statistically significant with P value of $0.009 \leq 0.01$

TABLE 11:

This test shows that the comparison between the three types of restorations in the normal side is highly statistically significant with P value of $0.009 \leq 0.01$

TABLE 12:

This test shows that the comparison between the three types of restorations in the restorative side is statistically significant with P value of $0.015 \leq 0.05$

DISCUSSION

The objective behind making of any kind of occlusal restoration or prosthesis is the restoration of function and occlusal harmony with mandibular movements for the long term and efficient functioning of the stomatognathnic system[1]. The oral sensory perception is so high that even a small deviation from the normal occlusal contact of natural dentition is quite uncomfortable to the patient. So the responsibility of the clinician is to understand the inherent nature of the pre existing occlusal relation present in the patient and correct it, if it is needed before proceeding on to restorative work.

Group function occlusion is mostly beneficial in both removable and fixed prosthodontics but they demand usage of semi adjustable or fully adjustable articulators, but they cannot be equal to that of the patient's TMJ[29]. Hence the importance of functional generated path articulation carved by the mandibular movements as put forward by MEYER[1,6] in 1933 and later modified by PANKEY –MANN[7,8,9,10].

In functionally generated pathway, it is considered that MOUTH IS THE BEST ARTICULATOR and the functional occlusal registration obtained were free of errors. This technique may seem to be simple but proper understanding and execution of the technique can produce excellent results.

Because of its simplicity, it is sometimes the object of derision by dentists who do not use it. Simplicity should not be confused with inaccuracy. The technique is capable of producing very accurate results, but it demands care and meticulous attention to detail[41]. This technique uses a tracing made in the mouth to capture the pathways traveled by the opposing cusps in functional mandibular movements, rather than employing an articulator to simulate the movements of the mandible. In this situation, the articulator is reduced to the role of a simple hinge[35,47].

This technique had an added advantage in excluding the use of

1. Complicated gnathological instruments,
2. It avoids the technical errors in casting procedures, in the distortion of opposing cast,
3. Errors in the occlusal registration,
4. Errors in the mounting and
5. Restoration of proximal contacts with the adjacent tooth as the fitting is checked prior to molding of occlusal surfaces[25, 38].

As any advantage cannot be without disadvantages, the demerits of the technique is that FGP can be employed only for single missing teeth, short span bridges and inlays and it is not useful in cases of long span bridges.

Selection criteria of the patients selected for this study was correctly observed. Intact dentition in the opposing arch with a good periodontal health, acceptable anterior guidance, elimination of posterior interferences is the prerequisites of the study. The patients with good neuromuscular coordination only can be included in the study. When the subjects were having teeth that are rotated, supra erupted, in cross bite, attrited and deep bite were not selected [25,35].

This protocol was strictly adhered to, in our study as the clusion and disclusion time obtained were compared against the time recordings in ideal cases as put forth by many studies.

Our study is based on evaluation of occlusal discrepancies between the fixed partial restorations fabricated by conventional technique and that which are fabricated by FGP by using T-Scan. The parameters like clusion and disclusion time help us in finding out this discrepancy by finding the deviation from normal range of values. In conventional technique inspite of careful attention to every aspect of fabrication and use of semi adjustable articulator the clusion and disclusion time values were having significant difference in all aspects with the

preexisting condition. In our study, analysis by **Wilcoxon signed rank test and Friedman test** the following results were obtained.

Pre existing and Conventional technique

The difference in clusion time between the restoration fabricated using conventional technique with the preexisting occlusion was significant with the P value of (P=0.028)

The difference in clusion time between the restorations fabricated using Conventional technique and by

1. Functionally generated path double casting technique - Significant.
2. Functionally generated path provisional restoration technique - Significant.

The difference in disclusion time on lateral excursion in the normal side, restorative side, and during protrusion, between the restorations fabricated using conventional technique were found to have a significant difference with the pre-existing occlusion ($P \leq 0.05$).

The difference in disclusion time on lateral excursion in the normal side and restorative side as well as during protrusion, between the restorations fabricated using Conventional technique and by

1. Functionally generated path by double casting technique - Significant.
2. Functionally generated path by provisional restoration technique - Significant ($P \leq 0.05$).

Two methods were adopted in this study to achieve this purpose, one was by double casting technique and another was by using a provisional restoration placed in the patient's oral cavity for 2 weeks and later on it was cast. It was concluded from the results that these two types of restorations had clusion time and disclusion times which were closer to the normal range when compared with that of the restorations made by conventional technique.

Pre existing and functionally generated path by double casting technique

The difference in clusion time between the restoration fabricated using functionally generated path by double casting technique with the preexisting occlusion was significant with the P value of ($P \leq 0.05$)

The difference in clusion time between the restorations fabricated using functionally generated path by double casting technique and

1. Conventional technique - Significant.
2. Functionally generated path by provisional restoration technique- Not significant

The difference in disclusion time on lateral excursion in the normal side and restorative side, during protrusion, between the restorations fabricated using functionally generated path by double casting technique were found to have a significant difference with the pre-existing occlusion ($P \leq 0.05$).

The difference in disclusion time on lateral excursion in the normal side and restorative side as well as during protrusion, between the restorations fabricated using

Functionally generated path by double casting technique and

1. Conventional technique -Significant.
2. Functionally generated path by provisional restoration technique- Not significant

Pre existing and functionally generated path by provisional restoration technique

The difference in clusion time between the restoration fabricated using functionally generated path by provisional restoration technique with the preexisting occlusion was significant with the P value of ($P \leq 0.05$)

The difference in clusion time between the restorations fabricated using functionally generated path by provisional restoration technique and

1. Conventional technique -Significant.

2. Functionally generated path by provisional restoration technique- Not significant

The difference in disclusion time on lateral excursion in the normal side and restorative side, during protrusion, between the restorations fabricated using functionally generated path by provisional restoration technique were found to have a significant difference with the pre-existing occlusion ($P \leq 0.05$).

The difference in disclusion time on lateral excursion in the normal side and restorative side as well as during protrusion, between the restorations fabricated using

Functionally generated path by provisional restoration technique and

1. Conventional technique -Significant.
2. Functionally generated path by double casting technique - Not significant

So it became evident from the study that use of functionally generated path technique helps a lot in creating restorations with a natural touch.

Clusion time and Disclusion time was first defined by **Kerstein and Wright** for T-scan. Clusion time is the elapsed time required during mandibular closure starting from 1st contact through to complete occlusal interdigitation. Disclusion time defined as the duration of time that working and non working molars and premolars are in contact during a mandibular excursive movement that commences from the habitual closure position through to the contact of anterior guiding surfaces. In short, it is the time with which posterior teeth separate from each other during jaw motion[47].

The comparatively decreased clusion and disclusion time (closer to the normal range) led to decreased time of contact of the teeth and their subsequent compression over the periodontium as well. This phenomenon led to decreased accumulation of lactic acid and allows adequate time for reoxygenation of the muscle fibers, thus the damage created to the teeth and its supporting structures is less[48].

The materials used in this study for implementing the functionally generated path technique such as residue free pattern resin (**GC Corp**)[42] and autopolymerizing resin[4] eliminate any dimensional changes likely to occur due to double casting. The usage of these residue free resins in dental casting technique is therefore currently recommended. These resins not only complement waxes or wax / resin compositions, but even replace them.

According to **Zimmermann EM,** functionally generated path is a "three dimensional static expression of dynamic tooth contact". Achievement of this harmony may seem to be a difficult task which requires the use of complicated gnathological instruments and materials[24].

FGP technique is an easier methodology adopted in our study which excludes the use of these complicated instruments and procedures. From this study it is found that the occlusal discrepancies after employing this technique were very meager and the time spent by the clinician and the patient is considerably reduced.

The parameter of clusion time and disclusion time selected in the study has very little flexibilities, that is the time period between 0.1- 0.3 sec was taken as the clusion time **in centric position** and the time period of less than 0.5 sec was set as the standard disclusion time **for eccentric positions**. It was found that the occlusal discrepancy was very minimal when the clusion and disclusion time was closer to these values. The more the deviation from these values, occlusal discrepancies also increased proportionately leading to more chair side time adjustments[60,61].

It was found in our study that the clusion and disclusion of the restorations fabricated by conventional technique was significantly different from the pre-existing values and it is the reason for the occlusal discrepancies encountered during our routine clinical practice consuming much of the time taken for adjustment. It is not only a matter of time that is important but arise a doubt in the confidence patient has in the treating clinician. Using

functionally generated path in the fabrication of fixed partial restorations excludes these errors and boosts the confidence of the patient in the treatment and the clinician.

As T-scan provides a bite force analysis against time it became evident that when the conventionally fabricated restorations were placed in the patient's mouth the bite forces developed in the restorative side was more when compared to the normal side. This supports our study and explains the reason for the premature contacts and increased clusion and disclusion time. When the restorations fabricated using the functionally generated path were placed in the patient's mouth the bite forces developed in the restorative side was more or less equal to the normal side. Thus our attempt in creating restorations with the harmonious occlusion became successful.

The reliability on disclusion time remains undoubted as it was revealed in many studies that lengthy disclusion times lead to increased muscle contractions in masseter and temporalis.

As any attempt to correct the occlusal discrepancies is irreversible, the method opted to do the correction is very deciding in determining the accuracy. According to **M Reza Moini,** the shortcomings like the influence of saliva, inability to store the data, nonstandardisation in thickness, strength, marking substance etc are ruled out when T-scan was used[20].

T-Scan is a computerized device introduced by William **L.Maness,** used to diagnostically quantify occlusal contacts in three new ways : balance plot, time display and comparison screen. It provides the dentist with greater ability to visualize, diagnose and treat complex occlusal problems. The display compares the occlusal contact patterns prior to and after treatment and assessing the similarity and reproducibility of closure patterns and at the same time recording it[23].

Our study is based on the accuracy of the results provided by T-scan. The T-scan systems measures the distribution of forces per tooth, both the halves of jaw and the center of

force each time, thus the premature contacts and interferences in dynamic occlusion are identified easily.

In-Sung Yeo and Jae-HoYang, Made a study where it was found that incorporation of group function occlusion in fabrication of fixed partial dentures is not easy when compared to mutually protected occlusion as it is difficult to achieve it by gnathologic instruments. Functionally generated path concept solves this problem easily where occlusal restoration of the prosthesis is customized to the patient's own occlusal patterns[29].

In our study also functionally generated path concept gave better results on comparison with the restorations made by conventional technique.

Edalat MP, Khadjavi K, The authors suggested the use of acrylic crowns as a base to carry the FGP recording material[5]. In our study also, a similar methodology was adopted wherein a simple, accurate and time saving technique for the fabrication of a fixed partial denture in which both a provisional restoration technique and a one piece casting were assimilated.

Kafandaris NM, The purpose of this article was to describe a technique which is more simplified. The functionally generated path was used to develop a functional core, which was utilized for constructing the interim restorations in acrylic resin. The interim restoration was inserted in the patient's mouth for 2-3 weeks to wear off any possible interference. A new functional core was now developed against which the ceramometal restorations could be fabricated[3].

In our study also the interim restoration was inserted in the patient's mouth for 2-3 weeks and subjected to function to wear out any possible interference and later it was removed from the patient's mouth and casting was done directly.

Melvin A. Engelman, Curtis L. Engelman, Conducted a study where it was said that FGP harmoniously reproduces the occlusal surfaces with minimal chair side adjustments and avoids

the need for counter models and adjustable articulators for construction of inlays, crowns and short span fixed partial dentures[4]. These results are in accordance with our study.

R. W. Wassell G. St. George R. P. Ingledew and J. G. Steele, Made a review on provisional restorations based on functions, materials and techniques. Their functions are comfort, positional stability, function, gingival health and contour, esthetics, diagnosis etc., the materials may be preformed crowns, self or light cure resin and cast metal[39]. These ideal characteristics of provisional restorations were reproduced in the provisional restorations fabricated in our study.

E Prashanti, Suresh Sajjan, Jagan Mohan Reddy, Accordingly, double casting technique is basically an error compensation step as it eliminates the inherent dimensional errors of indirect method. The possible errors are only related to investing, casting and polishing procedures and it avoids the tedious job of metal trimming where the occlusal morphology may be lost in an attempt to correct the interferences. Thus the occlusal morphology becomes closer to normal anatomy of teeth definitely leading to improved patient satisfaction and confidence[35].

Hajime Shirai,Jun-ichiSejima, Yuka Mantani, Conducted a study where patients with highly keen oral sensory complaints are restored with fixed partial dentures using double casting method. It not only provides functionally generated occlusal path but also precise outline form adapting to the surrounding soft tissues[38].

Satheesh B. Haralur, Within the limitations of the study, it can be concluded that if the balancing side interferences and centric slide was more than 2 mm the patients were found to have a strong association with TMD[46].

In our study also, preliminary analysis helps us to select cases with ideal occlusion subsequently clusion and disclusion time was used to find out the occlusal harmony.

Bogdan Oprea, According to his study the use of the T-Scan III system provides a better quality in the dental treatments providing information at a level of accuracy not obtained by conventional methods[59]. In our study also T Scan III system was used as a guide to find out the interferences between the restorations made with different techniques.

Kerstein, In his study found that combined right and left disclusion time were comparatively greater in cases of MPDS, Open occlusion, Orthodontic treatment[47].

In our study also the most ideal restorations had comparatively least clusion time and disclusion times.

Kerstein, John Radke, In his study concluded that the simultaneous recording of excursive function and muscle activity levels demonstrated the reduction in prolonged disclusion time creating a therapeutic effect in MPDS patients[47].

In our study also, disclusion time was used as a parameter to find the occlusal discrepancies.

It can be concluded within the limitations of the study that functionally generated path technique is a useful method in establishing the most harmonious occlusal relationship between the restorations and opposing teeth in fixed partial prosthesis.

SUMMARY AND CONCLUSION

This study was done to evaluate the occlusal harmony of the fixed partial restorations fabricated by functionally generated path technique and comparing it with the restorations fabricated by conventional means. The occlusal harmonies of these restorations were also compared with preexisting occlusion to find out the most harmonious restoration.

For this study to be made, six patients were selected who were free of any TMJ disorders, occlusal derangements and they all belonged to angles class I occlusion. The patients selected were usually with missing first molars as this is the most common teeth missing in the arch. The parameters like clusion and disclusion time were evaluated in seconds to find out the occlusal disharmony among these restorations. The clusion and disclusion time was evaluated in the preexisting condition before any treatment was started and it was set as a bench mark against which the clusion and disclusion times of the three types of restorations were compared. The three types of restorations were also compared among themselves to find out which is the more ideal restoration.

It was concluded according to the results that,

The difference in clusion time in maximum intercuspation and disclusion time on lateral excursion in the restorative side, normal side and on protrusion,

i) Between the restorations fabricated using functionally generated path by double casting technique and by provisional restoration technique – **Not significant** and

ii) These values when compared with the values of pre-existing occlusion were **closely correlated.**

The functionally generated path technique is simple and can produce fairly good results. Because of its simplicity, it is sometimes the object of derision by dentists who do not use it.

Simplicity should not be confused with inaccuracy. The technique is capable of producing very accurate results as compared to conventional casting methods, but it demands care and meticulous attention to detail.

Thus it was finally concluded that the restorations fabricated using functionally generated path technique by double casting method and provisional restoration method simulated the preexisting occlusion more closely and the difference between the two types of restorations were not significant. This proves that the functionally generated path technique is very useful and can be used whenever the situations permit. The functionally generated path technique utilizes a different approach to achieve occlusal harmony between the restoration and the other teeth in the mouth. It has been expressed as "three dimensional static expression of dynamic tooth movement".

Use of T-Scan in this study to find out the occlusal discrepancy was a reliable indication when compared to other intraoral methods but knowledge of the instrument and correct application of the technique is the highlight of this study.

Further studies can be made by extending this study using a large sample size to rule out the variations involved in small sample size. One disadvantage observed in T-Scan is that the markings obtained in the graph has to be transferred intra orally by manual methods, so further research in this aspect may be helpful to discover a marker which can be simultaneously used to make both intraoral and extra oral recording of discrepancies. Further studies can be made by follow up of these restorations for a period of one year using a large sample size. Study can be applied in edentulous locations on both sides of the dental arch.

Man's inventions cannot surpass Nature's bounds

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DISCLUSION TIME (IN SECONDS) FOR LATERAL AND PROTRUSIVE MOVEMENTS

TECHNIQUE	PRE-EXISTING			CONVENTIONAL TECHNIQUE			DOUBLE CASTING TECHNIQUE			FGP WITH PROVISIONAL RESTOTATION TECHNIQUE		
ECCENRTIC MOVEMENTS	RS	NS	P	RS	NS	P	RS	NS	P	RS	NS	P
1	0.48	0.44	0.46	0.64	0.60	0.65	0 .55	0 .59	0.55	0.53	0.52	0 .53
2	0.39	0.42	0.53	0.70	0.62	0 .76	0.42	0 .45	0 .59	0 .47	0 .52	0.62
3	0.49	0.43	0.48	0.79	0.79	0 .61	0 .48	0 .51	0 .61	0 .52	0.47	0 .54
4	0.52	0.48	0.39	0 .89	0.68	0 .71	0 .61	0.49	0 .38	0 .59	0.51	0 .58
5	0.62	0.59	0.61	0.83	0.94	0 .85	0 .67	0 .55	0 .69	0 .65	0.52	0 .60
6	0.37	0.41	0.51	0 .98	0.89	0.74	0 .57	0 .51	0 .58	0 .48	0 .47	0 .56

RS- RESTORATION SIDE,NS- NORMAL SIDE, P- PROTRUSION

OCCCLUSION TIME (IN SECONDS) IN MAXIMUM INTERCUSPATION

TECHNIQUE	PRE-EXISTING	CONVENTIONAL TECHNIQUE	DOUBLE CASTING TECHNIQUE	FGP WITH PROVISIONAL RESTOTATION TECHNIQUE
1	0.29	0.46	0.40	0.38
2	0.23	0.59	0 .31	0.34
3	0.41	0.75	0.41	0.51
4	0.32	0.76	0.47	0.38
5	0.25	0.56	0.51	0.48
6	0.29	0.58	0.37	0.37

INSTITUTIONAL ETHICAL COMMITTEE

Tamil Nadu Government Dental College and Hospital, Chennai - 3
Telephone No. 044 2534 0343
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Ref.No.0430/ DE/ 2014

Date: 07.08.2014

Title of the work: "Evaluation of occlusal harmony of fixed partial prosthesis fabricated by functionally generated path techniques using T-Scan"

Principal investigator: **Dr.T.Maria Singam,**
III Year MDS

Department : Prosthodontics and Crown Bridge
Tamil Nadu Government Dental College and Hospital, Chennai - 3

The request for an approval from the Institutional Ethical Committee (IEC) considered on the IEC meeting held on **31.07.2014** at the Principal's Chambers Tamil Nadu Government Dental College and Hospital, Chennai – 3

"Advised to proceed with the study"

The Members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above , submitted by the principal investigator.

The principal investigator and their team are directed to adhere the guidelines given below:

1 .You should get detailed informed consent from the patients / participants and maintain confidentiality

2. you should carry out the work without detrimental to regular activities as well as without extra expenditure to the Institution or Government.

3 You should inform the IEC in case of any change of study procedure , site and investigation or guide.

4. You should not deviate from the area of work for which you have applied for ethical clearance

5. You should inform the IEC immediately in case of any adverse events or serious adverse reactions. You should abide to the rules and regulations of the institution (s)

6. You should complete the work within the specific period and if any extension of time is required, you should apply for permission again and do the work.

7 .You should submit the summary of the work to the ethical committee on completion of the work.

8. You should not claim funds from the Institution while doing the work or on completion.

9.You should understand that the members of IEC have the right to monitor the work with prior intimation

10. Your work should be carried out under the direct supervision of your Guide / Professor.

SECRETARY 7/8/14

CHAIRMAN 7/8/14

INFORMATION SHEET

- We are conducting a study on "**EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN**" among patients attending TNGDC & H, Chennai. We are selecting patients for this study.
- In this study I have come to know that I will get a fixed replacement of my teeth after reduction of adjacent teeth and for that purpose I have to undergo a local anaesthetic injection.
- After that two measurements will be made and I am informed that I will be given temporary restoration for 2 weeks. After that it will be removed and replaced by a new temporary restoration.
- I know that 3 types of fixed replacement of teeth will be made and I will have to go to Best Laser Dental Clinic, Valasaravakkam for determining the accuracy of those restorations. All the expenses will be take care by the investigator.
- I am of the knowledge that an electronic instrument to detect any occlusal discrepancy will be used. I am willing to come for these procedures at least as 6 times to TNGDC & H.
- The identity of the patients participating in the research will be kept confidential throughout the study and In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.
- Taking part in the study is voluntary. I am free to decide whether to participate in the study or to withdraw at any time. I know that my decision will not result in any loss of benefits to which I am otherwise entitled.
- The results of the special study may be intimated to me at the end of the study period or during the study.

Name of the patient Signature / Thumb impression

Name of the investigator Signature Date

INFORMED CONSENT FORM

TITLE OF WORK:

"**EVALUATION OF OCCLUSAL HARMONY OF FIXED PARTIAL PROSTHESIS FABRICATED BY FUNCTIONALLY GENERATED PATH TECHNIQUES USING T-SCAN**"

Name: OP No:

Address: Case No:

Age:

Sex:

I, ……. exercising my free power of choice, hereby give my consent to be included as a participant in the clinical study. I agree the following:

- I have been informed to my satisfaction about the purpose of the study, nature of the treatment and study procedure.
- I understand that dentist may stop my participation from clinical study for any reason. I am also aware of my right to opt out of study at any time during the clinical study duration without any reason

I hereby give my permission to use my records for research purpose and I am told that study institution and dentist will keep my identity confidential.

Name of the patient Signature and Date

தகவல் அறிக்கை

நாங்கள் இந்த தமிழ்நாடு அரசு பல் மருத்துவக் கல்லூரி மற்றும் மருத்துவமனையில், **கடிபடை இயக்கவியல் பதிவு கண்டறியும் சாதனத்தை பயன்படுத்தி கடியொருத்தத்தை செயல்பட்டு உருவாக்கப்பட்ட மூன்று அதை நிலையான பற்தொகுப்புகளில் உயிரி அளவீடு மூலமாக மதிப்பிடும் ஆய்வு** செய்ய உள்ளோம்.

இந்த ஆராய்ச்சியில் பங்கேற்கும் நோயாளிகளின் விபரங்கள் ஆய்வு முடியும் வரை இரகசியமாக வைக்கப்படும். ஆராய்ச்சியின் முடிவு பற்றிய பதிப்புகள் அல்லது வெளியீடுகளில் யாருடைய தனிப்பட்ட விவரங்களும் பகிர்ந்து கொள்ளப்படமாட்டாது.

இந்த ஆராய்ச்சியில் பங்கேற்கும் உங்கள் முடிவு தன்னிச்சையானது. இந்த ஆராய்ச்சியிலிருந்து எந்த நேரத்திலும் விலக்கிக் கொள்வதற்கும் உங்களுக்கு வாய்ப்பு உள்ளது. உங்களின் இந்த தீர்மானத்தினால் உங்களுக்கு இம்மருத்துவமனையில் வழங்கப்படும் பயன்களில் எவ்வித மாற்றமும் இருக்காது.

இந்த சிறப்பு ஆய்வின் முடிவுகள், இந்த ஆய்வின் முடிவில் அல்லது ஆய்வின்போது ஏற்படும் எதிர்மறையான விளைவுகளை அந்நோயாளியின் நலன் கருதியோ அல்லது சிகிச்சையளிக்கும் பொருட்டோ நோயாளிக்கு தெரிவிக்கப்படும்.

ஆய்வாளரின் கையொப்பம் **நோயாளியின் கையொப்பம்**

தேதி

தன்னார்வ ஒப்புதல் படிவம்

ஆய்வு செய்யப்படும் தலைப்பு

கழுமை இயக்கவியல் பதிவு கண்டறியும் சாதனத்தை பயன்படுத்தி கழிவொருத்தத்தை செயல்பட்டு உருவாக்கப்பட்ட முன்று அலை நிலையான பற்தொகுப்புகளில் உயிரி அளவிடு முறைமை மதிப்பிடும் ஆய்வு

ஆராய்ச்சி நிலையம் : அரசு பல் மருத்துவக் கல்லூரி, சென்னை
பெஸ்ட் லேசர் பல் மருத்துவமனை, சென்னை

பங்கு பெறுபவரின் பெயர் :

பங்கு பெறுபவரின் எண் :

பங்கு பெறுவரின் பிறந்த தேதி : _____ / _____ /_____
தேதி மாதம் வருடம்

இந்த ஆய்வு சம்பந்தமாக நான் மேலே கூறப்பட்ட தகவல் படிவத்தை முழுமையாக படித்துப் பார்த்தேன் என்று உறுதி கூறுகிறேன்.

நான் இது தொடர்பான அனைத்து கேள்விகளுக்கும் நிறைவான பதில்கள் பெறப்பட்டேன்.

இந்த ஆய்வின் எனது பங்கு தன்னிச்சையானது என்றும் எந்த நேரத்திலும் இந்த ஆய்வில் இருந்து சட்ட உரிமைகள் பாதிக்கப்படாமல் விலகிக் கொள்ள சம்மதிக்கிறேன்.

மருத்துவ ஆய்வு அதிகாரிகள், எனது சிகிச்சை தொடர்பான பதிவேடுகளை பார்வையிடவும் எந்த நேரத்திலும், ஆய்வில் இருந்து நான் விலகினாலும் பார்வையிட சம்மதிக்கிறேன். எனது அடையாள குறிப்புகள் மூன்றாவது நபருக்கு தெரிவிக்கப்படமாட்டாது என்று புரிந்து கொண்டேன்.

இந்த ஆய்வு அறிக்கைகளை பயன்படுத்தவும், வெளியிடவும், நான் சம்மதிக்கிறேன். ஆய்வாளர் எனது மருத்துவக் குறிப்புகளை வெளியிட தடையாக இருக்கமாட்டேன் என உண்மையாக சம்மதிக்கிறேன்.

நான் இந்த ஆய்வுக்கு முன்னர் கூறிய மருத்துவ குறிப்புகளின்படியும் உண்மையாக சம்மதிக்கிறேன். மேலும் எனக்கு உடல் நிலை சரியில்லாத பட்சத்தில் ஆய்வாளர்களுக்கு தெரியப்படுத்த சம்மதிக்கிறேன்.

பங்கேற்பவரின் கையொப்பம் ..... இடம்..... தேதி.....

கட்டைவிரல் ரேகை

பங்கேற்பவரின் பெயர் மற்றும் விலாசம் .....

ஆய்வாளரின் கையொப்பம் ..... இடம்..... தேதி.....

ஆய்வாளரின் பெயர் .....